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ABBREVIATIONS.—D. = Discussion; I. = Illustrated
Names of authors are printed in *italics*.

Editors reprinting articles from this JOURNAL are requested to credit the author, the JOURNAL OF THE ASSOCIATION, and the Society before which such articles were read.

ASSOCIATION ENGINEERING SOCIETIES

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REVIEW OF ENGINEERING WORK IN THE STATE OF MONTANA, 1913-1914.

BY JOHN H. KLEPINGER,
PRESIDENT OF THE MONTANA SOCIETY OF ENGINEERS.

[Annual Address read before the Society at its Annual Meeting, held in Great Falls, Montana, April 11, 1914.]

With the closing of the session this afternoon, the official business of the twenty-seventh annual meeting of the Montana Society of Engineers will have become a matter of history. Our By-Laws demand that at this time a report be presented by the retiring President, showing the general condition of the Society, and containing a summary of engineering progress in the State during the preceding year.

There has been little change in the membership of our Society during the past year. Death has claimed one of our much respected members, and a few have been transferred from active to corresponding membership, but with the new members taken in our total active membership is about normal. The report presented by our Secretary this morning shows that we are in a sound financial condition and that the activities of the Society have not abated. It is gratifying to note the additional interest which has been taken in the regular monthly meetings during the past year, and it is to be hoped that the movement will continue to the end that every member who resides within a reasonable distance of the Society headquarters, will attend the monthly meetings and take part in the same by the presentation and dis-

cussion of papers. It is only by this means that the Society will serve the purpose for which it was organized, and that its proceedings will become of intrinsic value to the members. For the improved conditions noted above, much credit is due to our newly elected president, who in the absence of the speaker, presided at the greater part of the meetings during the past year and who has been untiring in his efforts for the upbuilding of the Society.

Our State was honored during the past year by a meeting of one of the national engineering societies, the American Institute of Mining Engineers. The headquarters of the Institute during the meeting were at Butte, but technical sessions were held, and trips of inspection to points of engineering interest were made, in both Anaconda and Great Falls. The attendance at this meeting included prominent engineers from all parts of the United States. The magnitude of our national resources, and their development from an engineering standpoint, was a revelation to many of these gentlemen, who frequently expressed their surprise and appreciation.

While our local society was somewhat eclipsed for the time being, by the presence of this larger and stronger institution, it should nevertheless be an inspiration to our members to know that much of the work which our visitors so highly appreciated, has been performed by our own members, and that a great many of the papers presented at that meeting were by members of our Society, who are also members of the larger institution.

Review of Engineering Work.

The engineering development of any state or country is closely associated with its development along other lines. Especially is this true of a new and rapidly growing State such as our own. In some cases the growth and improvement of a certain section will follow a development which has been largely engineering in its nature, such as the construction of a railway, the installation of an irrigation system, the building of some industrial plant, or the opening up of a new mining region. In other cases the engineering problems follow as a result of increased population or settlement. For instance, highways must be laid out and improved, streams must be bridged, and transportation facilities must be provided. Cities require sanitation, good and adequate

supplies of water, street improvement, lighting and transportation facilities. Many of these items, together with various industrial pursuits, make some form of power development necessary.

The past year has been an especially prosperous one in our State in almost all branches of its industries. Large numbers of settlers have established homes within its borders and good crops have been harvested. Reclamation service work has been advanced with renewed activity. Railway building and improvement has been especially active. Hydro-electric developments have been steadily advanced. Mining operations have continued with increased vigor. Municipal improvements have exceeded those of previous years, and the various industrial and commercial pursuits have experienced a year of prosperity above the average.

To be more specific and in justification of the above general statements, a brief review of some of the most important engineering work accomplished in the State during the past year, is presented below. This information has in most cases been furnished by engineers in charge of the work referred to, and the speaker wishes at this time to sincerely thank all those who so kindly responded to his request for data on work being carried on under their supervision.

United States Surveyor General's Office.

The importance of the work carried on under the supervision of this office is too well understood and appreciated to require discussion or emphasis at this time. Through the courtesy of Surveyor General J. G. Locke at Helena, I am able to present some interesting and significant data regarding the unsurveyed lands in our State.

The area of Montana is approximately 94,490,000 acres. Of this amount, about 21,000,000 acres, or over 22 per cent, is still unsurveyed in the field. In addition to this, 4,500,000 acres have been surveyed in the field, but the surveys are not yet finally accepted by the General Land Office.

Of the 21,000,000 acres of unsurveyed land, applications are now in for 4,000,000 acres. The Surveyor General advises that he would be sincerely glad if we could have a sufficient appropriation from Congress to do all of this work during the present year, but the indications are that the appropriation will be so limited

that not more than two or two and one-half million acres can be handled. With the additional applications that will surely come in during the present year, it is probable that the end of the year will show little change in the balance. It is most unfortunate that this work should be handicapped and the development of the State retarded for lack of funds to carry on these surveys and it would seem to me that it is within the province of this Society to exercise such influence as it may have, to the end that a larger appropriation from Congress may be secured for the purpose of carrying on this work.

Since the latter part of 1910, the work in this department has been carried on under the direct or salary system, instead of the contract system which was in use previous to that time. Surveys are now made under the direction of field supervisors, by the United States surveyors who are paid regular salaries. Under this new system the work is greatly expedited, is much more thorough and reliable and the cost per acre is only slightly more than one-half of what it was under the old system.

During the past year a little more than 2,000,000 acres were brought under the regular rectilinear system of surveys at a cost of 3.9 cents per acre for field work and one cent per acre for office work. This work involved the running of about 7,000 miles of line at an average cost of $13.85 per mile for field work. In addition to the above work, 282 individual mining claims were surveyed by metes and bounds. About 100 Homestead Entry Surveys within National Forests were made by officials of the Forest Service under the direction of the Surveyor General's office.

United States Reclamation Service.

The Northern Division of this service, which includes Montana, North Dakota and Wyoming, is in charge of Mr. H. N. Savage, Supervising Engineer, who has kindly furnished a brief summary of the work done on the various projects for the fiscal year ending June 30, 1913. There has been expended in this Division something over fifteen million dollars, about three-fifths of which has been for work in Montana. The Blackfeet, Flathead and Fort Peck projects are Indian Service projects and have absorbed about 23 per cent of the Montana expenditures. the remainder being used on regular reclamation projects. To complete the work which has been projected in this Division, it

is estimated that an expenditure of over thirty million dollars will be required. Of this amount there has been allotted for use in Montana, for the year 1914, about two million six hundred thousand dollars.

For a statement of the work done on the various projects, I can do no better than quote the summary furnished by Mr. Savage, practically verbatim.

Blackfeet Project, Montana.

No lands have been opened to irrigation by public notice. All lands covered by canals are alloted to Indians.

Construction During Fiscal Year.

Two Medicine Unit—On the Two Medicine Dam the concrete spillway and outlet structures were entirely completed and the earth embankment 93 per cent completed.

Badger Unit—The headgates for the Four Horns Canal of the Badger Unit were built and the canal excavation completed. Approximately ten miles of the Fisher Canal diverting from Blacktail Creek were excavated and cross-drainage culverts placed.

Surveys—Canal location of the Fisher Flats and topographic surveys of the Birch Creek Unit were completed.

Operation and Maintenance—No water has been delivered to the land for irrigation purposes. Maintenance work was done on the Two Medicine Canal, and both this and the Piegan Unit are ready for irrigating, with a total irrigable area of 26,649 acres.

Total building, operation and maintenance cost to June 30, 1913, $763,122.17.

Flathead Project, Montana.

Total irrigable area, 152,000 acres.

Construction During Fiscal Year.

Pablo Division—Contract work during the year brought the Pablo dams to approximate completion for 5,000 acre-feet storage. One large rock-paved drop and several small concrete drops and turnouts were constructed. During the winter 5,700 square yards of rock paving were placed on the faces of the Pablo dams.

POLSON DIVISION—A canal was constructed from the Pablo Feeder Canal two miles to connect with the Polson Canals, and 1.33 miles of sublaterals were built and structures placed ready for irrigation of about 1,000 acres.

POST DIVISION—A canal was built from Kickinghorse dam site and structures placed ready for serving a portion of the lands below, amounting to about 1,300 acres, but to reach 2,600 acres when completed. Work was completed on Lateral A to cover about 2,500 acres.

A large number of farm turnouts and weirs were placed scattered through the Jocko Division, also Mission and Post Divisions, where called for by the settlement of the country under previously built canals.

OPERATION AND MAINTENANCE—During the calendar year 1912, 111 irrigators applied 8,344 acre-feet of water to 4,203 acres. One hundred and thirty-eight applications for water had been made, but timely rains discouraged irrigation on the part of 27 farmers. To June 30, 1913, 171 water-rental applications had been made, covering 11,444 acres, and 2,685 acre-feet of water had been applied by 110 farmers under water rental contracts. The rotation system of delivery is in use. The average depth of water applied during 1912 was 2.45 acre-feet per acre in Jocko Division, 0.87 in Mission Division, and 0.55 in Post Division.

Total building, operation and maintenance cost to June 30, 1913, $1,122,801.93.

Fort Peck Project, Montana.

CONSTRUCTION DURING FISCAL YEAR.

POPLAR RIVER UNIT—Construction of the first two divisions of this unit, consisting of the West Side Canal, "B," and the East Side Canal "C," was begun in September, 1910. The "B" Canal, with lateral system and structures to all the allotted area, was completed in July, 1911. The construction of the "C" Canal was continued in 1911 until August, when work was temporarily discontinued on account of insufficient funds. Work was resumed on this canal in October, 1912, and continued to date. The major structures and 15 miles of the main canal are completed.

Total building, operation and maintenance cost to June 30, 1913, $272,759.18.

Huntley Project, Montana.

CONSTRUCTION DURING THE FISCAL YEAR.

EXTENSION OF CANALS—At the end of the fiscal year construction work on the extension of the project was practically completed, involving earthwork construction of 8.5 miles of extension of the main canal, 5.8 miles of extension of the highline canal, 9 miles of reservoir line canal structures, and the lateral system thereunder in the vicinity of Anita, Pompey's Pillar and Bull Mountain. On July 1, 1912, cloudburst damaged the canals and structures on this extension. Repair work was practically completed at the end of the fiscal year.

DRAINAGE WORK—Tile drain lines Nos. 1, 2, 3, 4 and 5, aggregating 3.5 miles in length were constructed for the relief of water logged areas in the vicinity of Ballantine and Newton. Plans were perfected for the construction of tile lines Nos. 6, 7, 8, 9 and 10, aggregating a total of 13 miles, and the construction of lines 6, 7, 8, and 9 was advertised and contract awarded. At the end of the fiscal year the contractor was making preparations to start work. Tile line No. 10 is to be constructed by Government forces.

OPERATION AND MAINTENANCE—The operating season opened May 9 and will close Oct. 1. Water was delivered under a four-day rotation, providing for a continuous flow in the laterals and the rotation of alternate farm units. The entire canal system, comprising 194 miles of canals and the pumping plant, serving the first unit of the project, was under operation.

Maintenance work consisted of the usual repairs and cleaning of canals. A number of wooden structures were replaced with concrete structures. The spring run-off during 1912 and the heavy rains of July 1 and 2 did considerable damage between Pryor Creek weir and the Northern Pacific Railway tracks and to prevent further damage earthen embankments were constructed and riprapped from the structure to the bridge.

Total building cost to June 30, 1913	$967,334.99
Total operation and maintenance cost to June 1, 1913	242,940.04
Additional allottment for 1914	154,406.00

Lower Yellowstone Project, Montana—North Dakota.

Construction During Fiscal Year.

One mile of telephone line was built to Savage headquarters, making a total of 80 miles of completed line. Lateral D was extended 1½ miles to irrigate 180 acres of land. Four and one-half miles of laterals were constructed by contract up to the end of the fiscal year on the extensions of laterals K, Q, R and S, which, when completed, will irrigate about 3,550 acres. Twelve hundred cubic yards of rock were placed below the apron of the Lower Yellowstone Dam.

Operation and Maintenance—During the season of 1912, from June 22 to October 20, 5,068 acres were irrigated, 4,915 being in Montana and 153 in North Dakota, and comprising 126 farms, of which 119 are in Montana and 7 in North Dakota. The small amount of irrigation done during 1912 was due to the heavy rains during the growing season. The duty of water was 1.19 acre-feet per acre. From the first of September to the close of the irrigating season water was delivered by rotation in periods of ten days. This method of water delivery reduced the seepage and also cut down the operating cost.

Total building, operation and maintenance cost to June 30, 1913	$3,166,001.24
Proposed expenditures for 1914	103,800.00

Milk River Project, Montana.

Construction During Fiscal Year.

On June 25, 1912, construction was started under contract on the first unit of the Dodson North Canal, which was practically completed during the calendar year 1912, to cover about 5,000 acres, the work including 10 miles of main canal, all laterals, the main canal headworks and all other structures. Contract work was begun in August on the extension of the Peoples' Creek Dike and construction proceeded until stopped by frost, at which time 5,565 feet of dike had been placed, 3,400 feet remaining to be built. With the opening of the season of 1913 work was begun under contracts covering a 10-mile extension of Dodson North Canal, the enlargement and extension of 34

miles of Dodson South Canal from Point of Rocks to Nelson Reservoir, and the Vandalia South Canal 46 miles long. On these canal contracts there had been completed on June 30, 1913, about 25 per cent of the Dodson North Canal, 50 per cent of the Dodson South Canal, and 38 per cent of the Vandalia South Canal.

Work has been in progress and is now nearing completion on the plans and specifications for the structures and laterals under the Vandalia Canal covering about 25,000 acres and under the extension of the Dodson South Canal covering about 3,800 acres. The plans and specifications for the completion of the Dodson North Canal and all remaining laterals and structures covering about 6,000 acres north of Malta were completed during the fiscal year and bids opened on August 6, 1913. In April, 1913, a construction camp was established at the Vandalia dam site, and earthwork is now in progress there with a small Government force. Permanent quarters have been provided for the force at the project headquarters at Malta by the construction during the fiscal year of a warehouse, barn, bunkhouse and substantial office building with concrete vault. These buildings were completed in June, 1913, at which time the office force was established in its new and permanent headquarters.

St. Mary Storage Unit.

The principal work consisted of the construction of a camp at Browning Station on the Great Northern Railroad and the enlargement of the camp at Browning town; the construction of a temporary camp at Kennedy Creek Crossing and of a permanent camp at St. Mary River Crossing; repairs to the headquarters camp near Babb and the construction of a mess house and repairs to the camp and sawmill at the foot of Lower St. Mary Lake; the construction of 28 miles of highway between Browning Station and St. Mary River Crossing; 39.6 miles of telephone line between Browning Station and headquarters camp near Babb; 24.4 miles of telephone line from Seville to Browning town and 3.2 miles of the St. Mary Canal between Kennedy Creek and St. Mary River crossing; the cutting of 950,000 feet b. m. of logs: the skidding of 550,000 feet b. m. and the rafting to the mill and the sawing 150,000 feet b. m. All of the above work was done by Government forces. In addition, the pipe ma-

terial for the St. Mary crossing pipe line was delivered on the ground and 1,439 feet were rivited into sections 32 feet long.

On May 28, 1912, the Board of Engineers approved the location and general features of the St. Mary Canal from the headworks to Spider Lake and recommended the construction by Government forces of that part of the canal between Kennedy Creek and the St. Mary River crossing, including the Kennedy Creek crossing, the Powell Creek crossing, and the Kennedy Creek dikes, and the construction by contract of that part of the St. Mary crossing pipe line lying west of the river, with the view of construction a temporary hydro-electric power plant at this point. Three and one-fifth miles of this section of the canal were excavated by Government forces with one long-boom shovel and one drag-line excavator operated sixteen hours per day. The shovel was started in operation August 28 and worked until December 31, 1912: resumed operation May 5, 1913, and was stopped and moved back south of Kennedy Creek May 24. The drag-line excavator was started October 12 and worked until December 19, 1912: resumed operation May 12, 1913, and was continued in operation throughout the balance of the fiscal year. The excavation of the trench for the St. Mary River crossing pipe line was also done by Government forces.

During the fiscal year the relocation of the St. Mary Canal east of Spider Lake was completed, and the right of way surveyed and mapped. The boundary line of the Lower St. Mary Lake Reservoir reservation was established and permanently marked. Topographic surveys of the Sherburne Lakes Reservoir and the McDermott Lakes were made. Test pits and borings were made, with good results, at the Sherburne Lakes Reservoir dam site to determine the suitability of the site for an 85-foot earth dam. One hundred and ten acres of the flowage lands around the lower end of Lower St. Mary Lake were broken and seeded to timothy and redtop, with oats as a nurse crop, to insure forage for Government animals.

Maintenance work consisted chiefly of protection work at the headworks of the Dodson North Canal and the placing of a few small structures in that system.

Water is being delivered to patented and homestead lands on a rental basis.

Total building, operation and maintenance cost first unit to June 30, 1913	$1,136,821.40
Total building, operation and maintenance cost St. Mary Storage Unit to June 30, 1913	463,298.61
Total	$1,600,120.01

Allotment for 1914:

Milk River	917,289.00
St. Mary Storage	549,602.00

Sun River Project, Montana.

Construction During Fiscal Year.

Camp Construction, Sun River Diversion—Camp buildings, including a water and sewerage system to accommodate 250 men, were constructed, and machinery installed to begin construction of Sun River Diversion and the first mile of Pishkun Reservoir supply canal.

Highway Construction—A highway was constructed from Gilman to the present terminus of the Sun River branch of the Great Northern Railway, to Sun River Diversion, a distance of 20 miles. The highway will be used in hauling supplies, materials and equipment for construction of Sun River Diversion and Pishkun Reservoir supply canal.

Operation and Maintenance—On the Fort Shaw Unit, during the season of 1912, the entire canal system, including 121 miles of canals and laterals, was in operation, irrigating 180 farm units, aggregating 6,284 acres. Thirteen thousand acre-feet of water in Willow Creek reservoir were available, but were not used, as the supply from the river was sufficient.

The irrigating season began June 1 and closed September 5: 20,392 acre-feet of water were diverted, of which 11,688 acre-feet were delivered to the land, the balance being lost by seepage and evaporation or wasted. A small maintenance force was employed at various times during the season in riprapping, building checks and turnouts, and cleaning ditches. The season of 1913 opened on May 19.

Total building, operation and maintenance cost; entire project to June 30, 1913	$1,043,590.27
Additional allottment for 1914	843,328.00

State Engineer A. W. Mahon advises that practically no new work has been started on the "Carey" Projects, but that good progress has been made in pushing to completion the work already started. The most important single piece of work in this connection, is the Swift dam in the Birck Creek Canyon, on the Valier project. This is a rock filled dam with concrete facing. It is to be 149 feet high to the level of spill-way. The reservoir covers an area of 455 acres and has a capacity of about 30,000 acre-feet. The rock fill for the dam was practically completed during the past year.

Mr. Mahon has inaugurated a comprehensive plan for compiling data on all water rights filed within the State, which will show the number of rights filed on each and every stream together with the amount appropriated under each, and also the total flow of each stream. Records of daily flow were obtained from about 135 stations in Montana during 1913. This work is carried on in cooperation with the U. S. Geological Survey and with the U. S. Forest Service. Larger appropriations are desired for carrying on this work and it is the hope of the State Engineer that the members of this Society will lend their assistance for securing the same, to the end that a complete record of the State's water resources may be made.

Hydro-Electric Developments.

The Montana Power Company has under construction two important water power developments. One of these is at the Great Falls of the Missouri, being situated about 8 miles down the river from the City of Great Falls. The other is at Thompson Falls, on Clark's Fork of the Columbia River.

The Great Falls development will have a capacity of 60,000 kw. and the Thompson Falls development a capacity of 30,000 kw. At the Great Falls of the Missouri, the river has a natural fall of about 78 feet. Immediately above the falls a solid concrete dam is being constructed the effective height of which, including flash boards, will be 75 feet, thus making a total developed head of 153 feet. The dam is designed to carry flash boards 14 feet high. It will have a crest line 1,000 feet long and an overflow section that will take care of 100,000 sec-feet of water, which is estimated as the maximum flood of the river.

Generator equipment will be installed to utilize the normal flow of 6,000 sec-ft. This equipment will consist of six main vertical

units, each unit consisting of a 15,000 h. p. turbine directly connected to a 10,000 kw. three phase, 6,600 volt generator. There will also be two exciter units each consisting of one 800 h. p. turbine and one 500 kw. generator.

At the Thompson Falls development a part of the head is obtained from a natural fall in the river, the remainder being developed by a solid concrete dam similar to that at the Great Falls except that it is not so high. At this point the dam will be in two parts.

The main channel of the river at the point of development is in the form of an obtuse ell. Across the angle of the ell there is what is known as the "Dry-channel" through which water flows only during high water periods. It is necessary therefore to dam both channels, the "dry-channel" being used as a part of the canal leading to the power house.

The dam in the main channel will have an effective height of 48 feet including flash boards which are 16 feet high. It will have a length of 1,200 feet on the crest. The "Dry-channel" dam will have an effective height of 40 feet including 12 foot flash boards, and will be about 240 feet long on the crest. The maximum developed head at this installation will be 64 feet.

Generator equipment will consist of six main units, each unit consisting of one vertical turbine of 8,000 h. p. capacity and one 5,000 kw., three phase, 6,600 volt generator. There will also be two exciter units each consisting of one 800 h. p. turbine and one 500 kw. generator.

These developments are not being installed under contract, but by the power company itself. To properly house and feed their employees it was necessary at the Great Falls development to build a complete new construction camp, a description of which will, I believe, be of interest to engineers.

Since there are about 600 men employed on this work, the camp has developed into a small village. Quarters for the men consist of a number of separate buildings, each accommodating 32 men. Each building is divided into three compartments, the central part being equipped with a stove, table and benches and is used as a general lounging room. At each end is a sleeping room. These rooms are provided with double deck steel bunks, equipped with springs. A locker is also provided for each man. There is a central, electric heated lavoratory and a barber shop with shower baths. There is one large dining room having a

seating capacity of 540 men and a private dining room for superintendent and staff. The kitchen is large and well equipped with modern appliances and is supplemented by a large cold storage room which is cooled by a modern ice making machine that is also used in making ice for various uses around the camp.

Besides the above mentioned equipment, there are, of course, buildings for the timekeepers, business offices, engineers, superintendent of construction, doctor's office, etc., as well as several private cottages for officers and foreman with families.

The camp is provided with a complete water system with hydrants and reservoir for fire protection.

Railways.

The past year has been one of especial activity in the construction and development of railways in Montana. According to statistics compiled by the Railway Age Gazette, our State lead all of the States of the Union in miles of new road constructed, the total amount being 393.8 miles.

The Chicago, Milwaukee & St. Paul Ry. Co. was the largest single builder, their line from Lewistown to Great Falls, being the longest continuous line built during the past year in the United States.

The electrification of the Butte, Anaconda & Pacific Railway has been one of the notable achievements of the year. The operation of this installation is being watched with interest by other roads and already the results have proven so satisfactory that the Milwaukee road has decided to electrify 440 miles of its main line between Avery, Idaho and Harlowton, Montana.

Soo Line—The Minneapolis, St. Paul and Sault St. Marie Ry Co., commonly referred to as the "Soo Line," entered Montana for the first time during the past year. About 55 miles of road was built in the extreme northeast corner of the State, from the North Dakota State line to Whitetail.

Northern Pacific Railway Company—No new line was built by this company during the past year, all work being in the nature of improvements in existing lines, consisting of ballasting track, replacing rail with that of heavier section, and replacing temporary bridges and culverts with permanent construction. In-

cluded in this work was one steel viaduct 576 feet long and 135 feet high on Fish Creek, about 45 miles west of Missoula.

A ventilating plant is being installed at Mullan tunnel about 20 miles west of Helena. The plant is located at the East end of the tunnel, which is about 3,900 feet long on a continuous 2 per cent grade ascending to the west, and will force air into the tunnel during the passage of west bound trains. Two Sturtevant Multivane fans will be used, each having a capacity of 275,000 cubic feet of air per minute. The fans are engine driven.

Great Northern Railway Company—During the year 1913 this company has extended a number of its branch lines, somewhat over 100 miles of road being constructed. A fifty-mile extension of the Plentywood line from Plentywood to Scoby was opened for traffic during the latter part of the year. The grading for this line was mostly light team work with some heavy fills where it crosses streams.

A line 42 miles in length from Power to Bynum was completed early in November and opened for service. The grading on this line was light team work.

A new line from Snowden to Fairview near the Eastern boundary of the State was completed during the year. Also a line from Fairview to connect with the Northern Pacific track at Sidney. On the Lewistown branch, grading was completed on the East end as far West as Fox Lake. For the first twenty miles East of Lewistown the grading on this line is very heavy work, on account of its passing over the Judith Mountain Divide. The line follows Boyd Creek from Lewistown to the summit for a distance of ten miles and then follows McDonnell Creek to Grass Range. At the Summit are two tunnels, one on these tunnels. The material to be removed from the long 900 feet long and one 3,100 feet long. Work is now under way tunnel is a soft sandstone, mixed with pockets of clay and coal veins and is of a general dry character.

A large electric power plant has been constructed at the Eastern end of the tunnel for lighting and running air compressors and drills. Power is being obtained from the Great Falls Power Company.

On the Shelby line near Collins two large steel bridges were erected to replace old timber structures. One of these is across the Teton River and is 2,600 feet long and 130 feet high. The

other is across Muddy River and is 900 feet long and 100 feet high. Both of these bridges are of the girder and tower type on concrete pedestals. The girders on the towers are 36 feet long and between the towers, 64 feet long, making a span from center to center of towers of 100 feet. These bridges were constructed to one side of the old structures making necessary a slight change in the line at each end of the bridge.

During the summer about 800 linear feet of reinforced concrete snow sheds were constructed on the main line between Highgate and Java on the West side of the Summit of the Rocky Mountains. This type of snow shed is being constructed in both the Rockies and the Cascade Mountains and the back wall of the shed up against the mountain side, is constructed of reinforced concrete, the top of the wall being 30 feet above the top of rail. Concrete pedestals are put in between the tracks and outside of the outer track to support posts which carry the roof. The roof being constructed of 12x12 timbers.

A considerable number of concrete trestle and slab bridges were put in on the main line to replace old pile and timber structures. These bridges are constructed in spans of 16 feet length on concrete piles. The deck is made in slabs of reinforced concrete. Gravel decking is put on top of this slab with a thickness of one foot under the ties. On the line between Whitefish and Rexford nine Howe Truss span bridges were replaced with steel girders on concrete foundations and on the line between Great Falls and Butte two Howe Truss Span bridges were replaced with steel girders.

During the year three modern passenger depots have been erected. One at Helena, one at Butte, and one at Lewistown. These buildings are constructed of concrete and brick with white enameled brick interior finish and marble floors.

Chicago, Milwaukee & St. Paul Railway Company—This road laid a total of 210 miles of new track in Montana during the past year. The Lewistown to Great Falls line with a total of 137 miles constituted the principal part of this construction. All grading, bridging and track laying on this line was completed in December, 1913, and mixed trains are now in operation. Ballasting is not yet completed but will be done by July 1, 1914.

The rough country through which this road passes has made

it an expensive piece of construction, but one which has offered many interesting problems from an engineering standpoint. The maximum curvature on this line is 8° and the maximum gradient is 1 per cent except a stretch of 8.6 miles of 1.5 per cent grade from Surprise Creek to Arrow Creek Bench where helper engines will be used. Between Lewistown and Great Falls there are six tunnels, the aggregate length of which is about 5,000 feet. Sage Creek tunnel is the longest being 2,000 feet long, and Surprise Creek tunnel the shortest, being 288 feet long. There are four Belt Creek tunnels being 450, 750, 650 and 850 feet long respectively. Tunnel sections are 16 ft.x21ft. 6 in. inside of concrete lining. On this same line there are five steel viaducts as follows:

Judith River, length,	2,200	feet;	maximum	height,	135	feet
Indian Creek, "	1,300	"	"	"	150	"
Sage Creek, "	1,800	"	"	"	163	"
Belt Creek "	600	"	"	"	200	"
Red Coulee, "	650	"	"	"	145	"

All of these viaducts are of the tower and plate girder type of construction.

All culverts under high fills are made of concrete. For ordinary embankments, cast iron, concrete, or corrugated pipes were used. The highest fill on the line is 150 feet and the maximum single cut was 150,000 cubic yards.

On the Great Falls-Lewiston line there was a total of 6,000.000 cubic yards of material moved, two-thirds of which was moved during the past year. On all lines in Northern Montana there has been a total of 8,000,000 cubic yards of material moved.

The Lewistown to Grass Range line, having a total length of 36 miles was completed and is operating mixed trains.

The Hilger to Roy line, having a total length of 26 miles, has the track laid from Hilger to Armells station, 12.5 miles. The balance being ready for track.

Twenty-three miles of track from Roy Junction to Winifred was completed and mixed trains are operating from Hilger to Winifred. No ballast has yet been placed on this line.

The Choteau line from Great Falls to Agawam, a distance of

66 miles, is about 80 per cent graded, but no track has yet been laid.

New terminals, consisting of yards, roundhouses, repair shops, freight houses, etc., are practically finished at both Great Falls and Lewistown and about 75 per cent of the station buildings at intermediate points are erected.

The proposed electrification of a section of the main line of the Milwaukee road between Avery, Idaho, and Harlowton, Montana, a distance of 440 miles, is the most progressive step toward general electrification yet taken by any steam railway, and exceeds both in length of line and tonnage per train, that of any other similar proposition. Gradients on this line, which crosses three mountain ranges, vary from three-tenths of one per cent to two per cent. Over these, it is proposed to haul freight trains consisting of 2,500 tons at a speed of 15 to 18 miles per hour and passenger trains at a speed of from 25 to 30 miles per hour while ascending the maximum gradient. Electric power for this line will be furnished by the Montana Power Company and will be delivered at seven points between the two terminal stations. It is understood that the overhead contact system of construction will be used, and that the line potential will be 2,400 volts, direct current. The transmission lines from power plants to substation will be 100,000 volts alternating current.

Butte, Anaconda & Pacific Railway—The successful inauguration of electric haulage on this road during the past year, is looked upon as the first step towards the electrification of all steam railways between the Missouri River and the Pacific coast. The electric haulage of ore trains between East Anaconda yard and the Washoe smelter ore bins, began on June 3rd, 1913. Passenger service between Anaconda and Butte was taken over on October 1st and freight trains on the main line on October 10, 1913. The total length of main line single tracks is about 30 miles. This together with the various yards and sidings makes up a total equivalent to about 90 miles of single track.

The initial equipment consisted of 17 locomotive units, 15 for freight and two for passenger service. Each locomotive weighs approximately 80 tons. Two units coupled together are operated from a master controller and will haul a 3,400 ton train at a speed of 15 miles per hour on a 0.3 per cent grade and 21 miles per hour on tangent level track.

Current is collected by overhead trolleys of the pantograph type. The overhead contact system is of the flexible catenary type. A 4-0 hard drawn grooved trolley wire is hung from a one-half inch galvanized steel messenger wire by loop hangers, which permits of a free vertical movement and decreases wear on contact members.

This is the first installation in this country using direct current at a potential of 2,400 volts. There are two substations about 26 miles apart, each of which is equipped with two motor generator sets consisting of synchronous motors direct connected to 1,200 volt d. c. generators, the latter being connected in series to give 2,400 volts.

Mining and Smelting.

The past year has been an active one for the mining industries of the State. Reports have been received from most of the larger companies and it is known that many of the smaller properties have been making rapid progress in development and construction work. The Butte & Superior Copper Co. has made several additions of machinery to its already well equipped plant, including a Kelly filter press for removing the moisture from oil flotation slimes; one 7 ft.x10 ft. pebble mill; one 8 ft.x30 in. Hardinge Mill; several Dorr Thickeners and Classifiers, and two storage battery mine locomotives. The Butte Duluth is enlarging its plant from 1,000 tons to 3,000 tons per day capacity, and the Bullwhacker has made some substantial additions to its equipment.

American Smelting and Refining Company—Several additions in the way of buildings and equipment were installed at the East Helena Plant of this Company during the past year. A section of steel balloon flue between the blast furnaces and the bag houses, was replaced by a brick flue. The steel flue had been in use about thirteen years and had become badly corroded from the action of the acid gases. The new brick flue is 234 ft. long by 15 ft. wide and 18 ft. high, inside dimensions, giving an area of 270 sq. ft. The greater part of the flue is built upon the ground on concrete foundations and the roof is of jack arch construction, supported on I-beams.

A Type E, size 40, motor driven A. B. C. suction fan was installed in the assay laboratory and serves to draw off the acid

fumes from the hoods and dust and fumes from the parting room, and gives perfect ventilation to the laboratory.

In line with a general movement throughout the country, this Company has organized a very complete Safety and Welfare Department during the past year, and has installed an immense amount of safety devices, including guards on moving machinery, safety railings and platforms, etc. This department is under the supervision of the Safety Committee, consisting of the Superintendent and various members of the operating staff. Closely identified with this Committee is a subcommittee consisting of workmen, the members of which are changed from time to time. In this connection, additional wash rooms and lunch room facilities have been added to the plant.

Anaconda Copper Mining Company—In the mining department of the Anaconda Copper Mining Company, the past year has been an active one. The average number of men employed has been about 9,500. The ore shipped to the reduction plants at Anaconda and Great Falls shows an increase over the preceding year.

Sinking has been carried on in many of the principal shafts, and the average depth of the mines is much greater than it was a year ago. Eight shafts are now at the 2,800, while three others are fast approaching this common level. The High Ore shaft is at the 3,400, and the Diamond shaft is now sinking below the 2,800 ft. level.

With increased depth it has been necessary to resort more and more to artificial ventilation. The air shaft with natural draught will no longer give the lower levels a sufficient amount of fresh air. For that reason a number of exhaust fans, varying in capacity from 50,000 to 100.000 cu. ft. of air per minute, have been installed at the collar of the various air shafts. The result has been very satisfactory, and in many of the mines the lower levels are equally as cool as the upper ones. Only recently a large three compartment shaft was started with the intention of sinking it to the 2,800 ft. level, to be used for ventilation only.

During the year two of the main hoisting engines have been equipped to run with compressed air, making a total, to date, of 10 main hoisting engines so equipped. Also five auxiliary engines have been added to those already running with air, making a total of eight.

The use of electric power is increasing rapidly, due not only to the installation of compressors and exhaust fans on the surface, but also due to the fact that pumps, which formerly used steam or compressed air, are now gradually being replaced with electrically driven pumps. All of the main shafts that raise the water to the surface have already been equipped with electric pumps, and the smaller pumps in the lower levels are being changed as rapidly as possible.

Added to the above, the trolley system for underground haulage, as well as on the surface, is being extended quite rapidly. The surface motors, used in the yards and on the ore bins, are supplied with a 500 volt current. For rapid and cheap transportation of ore and supplies underground the electric motor is very satisfactory, and each level that is driven is equipped with a trolley line and motor, as soon as the work warrants it.

Washoe Reduction Department—Anaconda Copper Mining Company—The most important work at this plant during the past year, of interest to engineers, was the beginning of construction of the Slime Concentration Plant, consisting of three buildings, known respectively as the Dorr Thickener Division, a building 635 ft. long by 64 ft. wide; the Round Table Division 275 ft. long by 60 ft. wide; and the Concentrate Dewatering Division, 72 ft. long by 30 ft. wide. A record for rapidity of construction was made on this plant. The order for steel was placed in the East on Oct. 4th, 1913: on Feb. 16, 1914, the buildings were complete and the machinery nearly all installed.

The first 20 ft. diameter basic lined converter of the Great Falls type to be installed at this plant, was built and put into operation during the year, and is giving excellent satisfaction.

Experiments on the leaching of sand tailings with sulphuric acid and salt solutions have proceeded to a point where the success of the scheme seems assured. A similar scheme for the treatment of slime is being developed and promises to be successful. The plant was shut down for ten days in October for the purpose of cleaning out the dust from flues connecting the dust chambers at furnaces with the main dust chamber leading to stack. About 11,000 tons of material were removed, resulting in a marked improvement in the draft and general working conditions of the furnaces.

B. & M. Reduction Department—Anaconda Copper Mining Company—An expenditure of over two million dollars is being made in rebuilding and remodeling this plant. About one-half of the work was done during the past year. The main building which cover converters and reverberatory furnaces, and extends along the front of the blast furnaces in such a manner that matte produced by them can be handled by the over-head traveling cranes, is 828 feet long. This is a brick and steel building with plank and composition roof. It is equipped with three 40-ton electric over-head traveling cranes, that operate over the full length of the building. The span of the crane run-way is 56 ft., the crane rail being 42 ft. above the converter floor. These cranes embody the latest improvements in crane construction, being equipped with steel cables, high duty motors, enclosed gears, and improved automatic brakes. Each crane has three hoist of 10, 25 and 40 tons capacity respectively.

Two new 20 ft. basic lined converters were built and put into operation. An old converter of the same design was moved and equipped with new machinery, making a total of three converters for the plant.

One new reverberatory furnace has been built and put into operation and material has been ordered for the second furnace. These furnaces are 102 ft. long by 22 ft. wide inside. Their design is a departure from the usual form of construction. Instead of a large number of backstays with tie rods across the top, the binding on these furnaces consists of a plate steel shell which completely encloses the sides and ends. Buckstays are placed at intervals of about 13 feet. The lower ends of these buckstays are held by the slag and concrete foundation, and the upper ends by cast steel struts or braces which stand at an angle of about 50° from the horizontal. The buckstays are prevented from being pushed up, by heavy tie rods which lead down into the slag foundation, the lower end being reached by means of a tunnel cast in the slag. Being clear of all tie rods across the roof, the furnace is fettled from hopper bottom push cars which run on tracks supported by the side wall and roof.

These are commonly referred to as direct-fired furnaces. The firebox which is built adjacent to, but independent of the furnace, is really a large gas producer. It has a brick-lined steel shell, and is approximately 26 ft. by 17 ft., inside dimensions.

The bottom of the firebox or producer consists of 14 water-cooled toothed grate rolls. These rolls are operated by a motor and are so arranged that they may all be operated at the same time or any one or more of them may be stopped.

The operation of the furnace to date has been very satisfactory. An efficiency exceeding that of the old furnaces has been obtained, notwithstanding the fact that the secondary air has not been pre-heated.

Designs have been made and material ordered for two "hot blast" stoves, or regenerators, which will utilize the waste heat from the furnace for pre-heating the secondary air and thus make the furnace regenerative. These stoves will be of the vertical, two-pass type. They are 25 ft., 6 in., inside diameter, by 80 ft. high. It is expected that the air will be heated to a temperature of from 1,200 to 1,500° F., from which a material increase in smelting efficiency will be obtained.

For delivering fuel and charge to these furnaces, two 10-ton standard gauge electric locomotives and 12 hopper bottom dump cars have been provided. The locomotive is equipped with an electric driven automatic air compressor and receivers, and both locomotives and cars are equipped with air brakes. The cars are also dumped by the use of air. Current for operating these locomotives is collected from a third rail.

For handling slag from both reverberatory and blast furnaces, three 25-ton standard gauge electric locomotives and 14 air dumped cinder cars are provided. Twelve of these cars are 300 cu. ft., or 30 tons capacity, one is 260 cu. ft., or 26 tons capacity, and one is an end dump car of 15 tons capacity. Both locomotives and cars are equipped with air brakes.

In addition to the above new buildings and equipment, there was constructed during the past year, a brick and concrete, steam-heated thawing shed, 210 ft. long by 61 ft. wide; also a steel and brick electric shop 135 ft. long by 55 ft. wide. This latter building also serves as an electric locomotive "round-house" and repair shop.

Highway Improvements.

The Good Roads movement has continued to be a live issue all over the State. County, state and national organizations are doing good work in developing sentiment favorable to a sys-

tem of good roads and, while no very definite system has yet been outlined, or any very concerted action taken, it is expected that some plan will be adopted soon which will insure a systematic development of roads and that will secure the highest efficiency and economy in their construction.

The State Highway Commission is handicapped by lack of funds, from accomplishing the greatest good, but valuable data is being compiled on the amount and cost of road work and a study of conditions made, which will be of use later.

According to a report by Mr. Geo. R. Metlen, Secretary of the Board of Highway Commissioners, the various counties of the State have expended during the fiscal year ending Dec. 1st, 1913, a total of about $2,000,000 on roads and bridges. Out of a total of 110 bridges reported to Mr. Metlen, covering about one-third of the total expenditure for bridges, 68 were built of steel, 5 of reinforced concrete, 5 combinations and 32 of wood.

Inquiries were addressed to the City Engineers of the leading cities of the State for information regarding municipal improvements. From the replies received, the following tabulation is made up—showing the principal item of new construction during the past year.

City	Paving Sq. Yards	Sewers Lineal Feet	Water Mains Lin. Ft.	Cement Sidewalk	Feet Cement Curb	
Great Falls	59,556	6,971	16,345	298,033 sq. ft.	70,869	—One mile street graveling
Missoula	5,734	966	....	182,600 "	785	
Lewistown	22,000	18,480	5,400	7,000 lin. ft.	7,000	
Anaconda	....	....	....	7,000 "	....	
Billings	44,449	16,730	....	12,000 sq. ft.	1,370	
Livingston	....	6,840	....	64,850 "	....	
Havre	....	($1,800)	15,000 ($10,056 Concrete Stand Pipe)	129,146 "	7,360	—286 Standards for Street Lighting.
Miles City	....	13,200	10,560	....	....	2 miles sidewalks and curbs, 4 miles street graveling.

Before closing, I feel that a word of reference to our State Educational Institutions which offer courses along scientific and technical lines, will not be out of place. These institutions are all prospering and improving in every way by the addition of new buildings and equipment and new courses in engineering instruction. By a recent Legislature enactment our four state

schools are to constitute the University of Montana, the control and supervision of which is vested in the State Board of Education. In order to avoid duplication of courses in various schools, all engineering courses with the exception of the course in mining engineering, will be concentrated in the College of Agriculture and Mechanic Arts at Bozeman.

As individuals as well as an organized body of engineers, we owe it to our State Educational Institutions to take an interest in their welfare and to co-operate with them in any way that is consistent for our mutual benefit.

In closing, I wish to express my appreciation of the honor which you have conferred upon me in serving as your executive officer during the past year and to thank all of those who have so loyally assisted and co-operated with me in advancing the interests of the Society.

[NOTE—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

CITY CHARTERS IN GENERAL AND THE PROPOSED CITY CHARTER OF ST. LOUIS IN PARTICULAR.

By Carl Gayler,
Member of the Engineers' Club of St. Louis.

[Read before the Society, March 25, 1914.]

For the second time within a few years, we are asked to wipe out the organic laws of our City and to substitute a new Charter. Every citizen should be vitally interested in this question. As the scope of activity of our Club in public questions has been widened through recent amendments to our Constitution, it seems eminently proper to bring this matter before the Engineers' Club.

Voting on new charters for towns and cities is going on all over the country on such a scale that charter making deserves to be called a national movement. Hardly a week passes without one or two charter elections taking place. One of these recently adopted city charters has been fully explained to us during the last two weeks.

According to John Fiske, historian, a town or city can be governed in either of the two following ways: (1) like a business concern, say a railroad company or an automobile factory with its president, board of directors, officials, etc.; (2) like a small republic with its mayor and representative legislative body or bodies and its officials. The two methods are irreconcilable; like questions of religion, they can hardly be discussed with patience, strong sentiments are at once aroused for or against either the democratic or the undemocratic system. Some people prefer living under a monarchy to living in a republic—I do not—some people would rather live in Berlin or St. Petersburg than in Edinburgh or St. Louis—I would not—and I, for one, am glad that our Freeholders have steered clear of the "business" system.

To show you how far the advocates of the business charter dare to go, take the Denver charter or the Dayton charter, or probably a dozen other similar charters adopted recently: *Party politics are to be eliminated from city elections and city governments*: A wonderful method of electing has been devised, the "preferential method," I think it is called, as if it were not hard enough as things are now to get people to vote, without complicating the method of voting! I have not grasped its beauty and

I do not intend to, but I say that it is *nonsense* to vote on national party lines in municipal elections but that it is a *crime* to prevent free citizens from doing so if they do not know any better. If things go much farther in this direction, we will soon be electing our representatives like the Russian votes for his Duma.

Look up your history, read about the free cities of ancient times and the middle ages, call back to your memory the wonders of Athens and Florence, the art achievements of little Nuremberg, the glorious monuments and works of art of Antwerp and Amsterdam. Macaulay says that the one City of Florence has done more for mankind than monarchial France from the days of the Capets down to the last of the Bourbons. Those were *Free Cities, small Republics,* not Business Concerns! It is true they were torn to pieces by parties, the war cry of Bianchi and Neri, of the Nobles and Commons was heard in Florence again and again; the Guilds fought for centuries in the German and Dutch Free Cities and yet, with all this strife, what wonderful results! How quiet and orderly and unproductive these cities would have been under "business administrations,"—quiet as graveyards! A Pericles and Praxiteles, Dante and Michelangelo, Duerer and Rembrandt can no more arise in cities that have lost their freedom, than can an Abraham Lincoln in a monarchy!

There seems to be a queer connection between floods and city charters. The Galveston flood has given to the world the commission form of city government, the Dayton flood, the commission-manager form. Now, St. Louis is not threatened by any flood, nor ever will be; as far as "watery" floods go, ours is a "dry town;" nor can the recollection of the result of the last charter election have been an incentive to a renewed effort in the same direction. The question, therefore, why should we have a new charter election at all, seems pertinent.

It is claimed that our present charter is old,—nearly 40 years old. This statement is misleading, is only partly true. A charter properly amended to suit changing times never becomes old, in fact, its true age should be reckoned from the date of the adoption of its latest amendment rather than from the date of its first adoption.

A charter, furthermore, is the one great school for the

teaching of self government, its very defects stir up a healthy public sentiment to discuss, amend and fight over and thus add to our political experience. Simply wiping out a charter means begin all over again.

It does not seem likely, however, that a movement for a new charter in this city should have taken place merely on account of the age of the present charter, as long as this charter worked well. Who cares for the age of the United States' Constitution? There must have been some deep-seated discontent with some of the important features of the charter and there surely was at least one such feature,—the House of Delegates.

In speaking of our House of Delegates, as at present constituted, or rather in defending it, I feel that I am skating on thin ice, that I will hardly be listened to with patience. All the so-called better elements of the city, every minister, every citizen who frets over the non-completion of the Free Bridge, are bitterly opposed to it, and yet I claim that as an integral part of our present charter; it is a feature excellent beyond reasonable criticism.

Representation by wards is necessary in order to obtain true representation, as necessary in an American city as it was in ancient Rome. The different parts of our city, our river wards, South St. Louis, North St. Louis, Middle St. Louis, our West End,—all have different interests, even differ in character. That I do not stand alone in this opinion is proved by the fact that our Board of Freeholders retain this feature.

It is claimed that it does not work well, that the House of Delegates is composed of saloonkeepers, storekeepers, etc., instead of "high class" citizens. Suppose it is (and generally it is, and I, for one, am far from branding saloonkeepers and storekeepers indiscriminately as undesirable citizens),—but suppose it is thus composed, where does the blame rest? Did you before the election, agitate in your ward, try to pick out a worthy citizen for candidate, get the assistance of your neighbors and friends to rally to his support at the time of election? You know you did not; if pinned right down, you will have to confess that you hardly know the boundaries of your own ward. It may seem like a paradox, but I claim that the worse the House of Delegates is, the better it is for the city. Like the voice of the preach-

er in the wilderness, it calls on the citizens to do their duty; it is the political training for the masses.

To have in addition to a house which represents the wards, a second house of citizens elected at large, is an ideal combination. The Delegate will more particularly look after the interests of his own ward as to streets, alleys, sewers, water, etc., the man elected at large will be invaluable for broader questions, such as creating the "City Beautiful," maintaining and extending our system of parks and boulevards, extension of waterworks, extension of city limits, etc. The Board of Freeholders deserves great credit for the wonderfully ingenious way in which they have succeeded in combining the main features of both systems in one. Whether the scheme will work in the manner which the Freeholders expected, remains, however, an open question.

To sneer at this scheme of two houses as a copy of the United States' Constitution, is no argument at all. There is on this planet no nobler constitution than ours, then why not copy it for our little republic?

I claim that our present city charter has no defect which cannot be reached by amendments. Let us not forget either that it was the first among all city charters in this country worked out by the citizens themselves, not forced on them by the legislature. It has been amended again and again, until now it contains even the latest popular idols, the Initiative and the Referendum.

Mr. Flad has kindly sent me the preliminary draft of the proposed charter from which I see that we are to have a reconstructed Board of Public Improvements, and also the "Recall." Not wishing to impose too much on your good nature, I will take up in detail only these two features of the new charter.

I will here state, however, that not before looking over the work of our Freeholders, did I appreciate the amount of labor involved. We may not agree with their opinions but we cannot help admiring their patriotic devotion to the work.

I need not go into details of the organization of our present Board of Public Improvements, as you are familiar with them, but will mention some of its good features and some of its shortcomings.

The Board of Public Improvements is principally an administrative body, its members, therefore, very properly, are ap-

pointees of the mayor. The Board has also legislative functions, inasmuch as it possesses the exclusive initiative on all public works; its president, therefore, very properly again, is elected by popular vote. The members hold over two years after a new mayor has been installed and this much criticised proviso, against which strong theoretical objections might be brought forward, has worked exceedingly well. To point out just one instance: the man who transformed St. Louis from a dirty, macadamized town into a clean city with modern pavements, granite, asphalt and preserved wood, Gen. John W. Turner, would never have held his position through four consecutive terms under administrations of different political complexions, without this safeguard. This very safeguard, the feeling it gives to every member of the Board, that his position is not altogether at the mercy of every political wind that blows, has procured to us the service of men of whom we can be proud. Scan the list of names of the men who have acted and who are now acting on this Board; the list well stands scrutinizing!

To anticipate somewhat I will say right here that it is the deliberate removal of every vestige of such safeguards for men in high positions which makes the recall, in my judgment, a very "stone of offense."

On the other hand it is true that the departments should be re-arranged; the Harbor Commissioner seems out of place in the Board and the Building Commissioner might be substituted. The salaries are inadequate and, what is more important, the one excellent feature of the proposed new charter—the civil service system—should be incorporated in its workings.

The Board of Freeholders has also provided for a Board of Public Improvements, called the Board of Public Service. Its organization is peculiar. The president seems to have the following duties assigned to him:*

(1) Charge of Public Utilities.
(2) Operation of Waterworks.
(3) Control of Municipal Electric Lighting Plant.

His first duty is negligible, as control of Public Utilities has been taken away from the city. The second and third duties

*[Editorial Note. These duties were assigned to the Director of Public Utilities in the final draft.]

the president divides with the "Engineer of Designing and Construction," consequently his position would be clearly defined by the title of "Supervisor of Waterworks and Municipal Electric Lighting Plant." It may be asked therefore what beside his title, makes him the President of the Board of Public Improvements? Like the other members of the Board, he is appointed by the mayor, like them he deliberates and votes in the Board and *has no control whatever over the other departments.* So I ask again, why is he called President of the Board of Public Improvements?

The "Director of Streets and Sewers" combines portions, very small portions, of the duties of the present Street Commissioner and Sewer Commissioner. Now what, beside his routine work in the Board, is the gentleman to do, considering that the preparing of plans and specifications, as well as the building and reconstructing of all streets, alleys and sewers does not come within the scope of his position but forms part of the duties of the "Director of Engineering and Construction?"* Again why should then this Department Chief without a Department, this Street and Sewer Commissioner minus a Street Department, minus a Sewer Department, be a man of "technical training and experience?"

But right here we come to the one refreshing feature of the new scheme. City Charters, organizations of City Departments are rather dry subjects, but now we see looming up in this "Director of Engineering and Construction," the fascinating figure of the "Universal Genius." As a rule genii, universal or otherwise, may be said to be rare in City Halls, so we heartily welcome this *rara avis*.†

The man has simply to know everything, has to be able to design and construct anything! From a hundred million gallon "hextra power" pumping engine to a six-inch valve, from a 25 ft. reinforced concrete sewer to a 4 in. drain, from the latest powerful dynamo to the length of a pole, from the wearing qual-

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*[Editorial Note: In the final draft "all plans and specifications for such work shall be prepared under the direction of the Board," and may be assigned by it to whomever it selects.]

†[Editorial Note: This "rara avis" does not appear in the final draft. Vide.]

ities of different street pavements to the strength of a viaduct, from a park drive to the aesthetic effect of a group of hemlocks!

And as the last straw on the camel's back (not meaning any disrespect to the gentleman) the Director of Engineering and Construction is City Architect likewise.

Page 43, line 930: "His Deputy, as hereinbefore provided, shall receive a salary of not less than $5,000.00 per annum." His Deputy! Why the man needs a dozen such Deputies!

I rather suspect that in the discussion which is to follow this paper, it will be proven that I am all wrong in the above statements, but would not this by itself be an indictment of the Board of Freeholders? I lay no claim to being a genius (universal or otherwise) but I claim to possess ordinary common sense and I confess to being puzzled. I have tried to get a clear picture in my mind of the working of this Board, particularly as to the splitting up of the Departments as to maintenance and new work, but have failed. I might as well have consulted the Egyptian Sphinx. The fundamental requirement in an organic law—clearness—has not been obtained in the work of the Freeholders.

Compare our present Board.

Any high school pupil can easily grasp the workings of the present Board of Public Improvements: *The Board of Public Improvement consists of five members, each member the head of his department, and a President who has supervision over the five departments.* Can anything be clearer, more concise? Isn't this utter simplicity and crystal like lucidity alone, not to speak of the ease and certainty with which responsibility can be located, —an unanswerable argument for retaining our old Board?

But is it necessary at all to take up such details? Is not the unparalleled record of the Board of Public Improvements sufficient to brand any attempt to tear it to pieces as unwarranted? Can any one of you point out a Municipal Board in this or any other country, in this country in particular, with the Argus eyes of its restless press forever on the lookout for scandal or corruption, which has retained through nearly 40 years the confidence of the citizens? On this record our Board of Public Improvements nearly as now constituted, can and I trust, will stand for years to come.

We Engineers may be pardoned for claiming a good part of the credit for this record. The members of the P. B. I. have

never all been Engineers, but there have always been enough of them in the board to keep its character on a high level; in fact there have been but few of the really prominent members of our profession in this city who have not, at one time or another, served on that board.

Now let us take up the law called "the Recall."

The Recall is one of those laws which cut deeply into the body politic, it is essentially an organic law and deserves the fullest consideration.

Poets have sung of a "Golden Age," the archeologist tells us of a Palaiolithic and Neolithic Age, of an Age of Bronze, of an Age of Iron. Mark Twain has introduced us to an Age of the Mighty Dollar. Now the peculiar age in which we live deserves, in my opinion, likewise a name of its own. We will call it the "Age of Laws." Do not misunderstand me, not an "Age of Law," distinguished by particular reverence for the law or observance of the law; no, just plainly an "Age of Laws" (plural).

For any grievance we may have about something "in heaven above, or in the earth beneath or in the waters under the earth," our first and last remedy is some new law. Just as the good people of Dayton propose to fight the laws of nature by means of a new Charter, so we overcome all our troubles by new laws.

Almost daily, at our home, in the street cars, in our office, we may hear discussions on most any subject, except perhaps the weather, ending with: "there ought to be a law!"

The idea of self-help, the feeling that we ought to rely on ourselves, and, if required, combine with others to fight the evil, seem to become obsolete.

Mr. James Bryce in his "American Commonwealth" remarks that the foreigner who travels in this country, is never reminded of any state boundary, and, without looking up the time table, can hardly tell whether he is in Ohio or Michigan. Just let Mr. Bryce come back and travel in his sleeper over this broad land and if he does not, from early morning when he wants a drink of water or to clean his teeth, till late at night when he may feel like taking something stronger than water or like sitting down to a quiet game of poker, run up against 57 varieties of sets of state laws, which forcibly remind him of state boundaries, one set of laws more absurd and annoying than the other, each interfering with his life-long habits, it is only because there are not more than 48 states in the Union.

The weary traveler, of a winter night, in his lonely bed in a hotel in some Missouri country town gets cold feet. The law steps in and fixes the minimum size of the bed sheets.

Some people do not know how to behave like Christians, they go into saloons and get drunk. The law steps in and, at one fell swoop, stops all drinking.

A man loses his temper and uses language which, if omitted from one of Shakespeare's most effective scenes would leave them "stale, flat and unprofitable," language which the Father of our Country used so forcibly towards General Lee at Germantown. The law steps in, "collars" the man and fines him.

Is it a matter of surprise then if in the case of apparent shortcomings of representative government, we apply our usual remedy, a new law?

We elect a magistrate. After the man has been in office a while we find that, after all, he is not the kind of man we wanted. The law steps in (i. e. the law would step in if the new Charter would pass), the man is "recalled."

It is all so simple! Elections are as old as the hills.

Electing goes on through the centuries: Greek and Roman, the Free Cities of Italy, Germany and the Netherlands, England and our country, in fact every people that ever left a lasting impress on history, come to regard this method of expressing their will as their birthright and their weapon against tyranny and decay.

But a time comes, and not so many years ago either, when electing by popular vote does not seem to fulfill reasonable expectations, when something becomes rotten in many of our town—city—or state—Denmarks. After more than thirty centuries of popular elections an era of apparent failure of the *vox populi* seems to have arrived.

By a strange coincidence, at about the same time the Sovereign People somehow become tired of voting; it is such a bother to register, to go to the polls, to waste valuable time in waiting in line for your chance. Whether you or I voted is, after all, not so important; there are plenty others to do it; we had our election, isn't that enough? And so naturally the "undesirable citizen" gets the upper hand, until at last the people rise in their might, resolved on action!

Now in previous, less enlightened periods of history, the people in such cases, not knowing any better, laid the blame on themselves and "highly resolved" not further to neglect their civic duties.

But we know better. This being the "Age of Laws" we just rectify the whole matter by law—and lo and behold the "Recall" is born!

It is so depressing anyway to blame oneself; so unnecessary too as long as there are other shoulders. Thackeray says that of all human emotions self reproach is the most sparingly applied by mankind. But now with the Recall we are truly free and all blame can be laid on the man we elected. Let him beware or woe to him! The Recall has the further advantage that we do not need to be so particular at Primaries and Elections, isn't the Recall, like the poor, always with us?

You all know that this seeming latest product of statesmanship, said to have originated in the northwest corner of our country, is nothing new. The methods were different, that's all. Centuries before Christ, Greek and Roman recalled, each in his own peculiar way. The cultured Athenian banished the unpopular leader (by ballot, too). Now the Greeks have always been an idealistic people, way up in the clouds around their Olympus with their godless gods and goddesses. So they didn't see that the banished man might some day come back, might "recall himself," (you find in Shakespeare's Timon of Athens a fine example of such "Self Recall"). The Roman was, above all, practical. He knew that after a man had been hurled down from the Tarpejan rock and had every bone in his body broken, he would never come back to endanger the Res Publica.

Now *we* are a highly civilized people; we are what some people like to call a Christian nation; our method of Recall, therefore, is more refined. We merely request one of our leading citizens, a so-called "high class man," to drop his work and to go through the trouble and expense, slander and rake-up, lies and denunciations of a municipal campaign, let us say for Mayor, with the distinct understanding, however, that the moment he does not suit our fancy any longer, he gets fired!

How simple again! I leave it to you to picture to yourself the joy, the eagerness of the high-class man to accept the nomination.

Many well meaning people believe that the Recall is intended to punish the man high in office who breaks the law; nothing of the kind! For such men, for men of the Sulzer type, we have the Impeachment. The Recall strikes the man who becomes *unpopular,* the man who has the strength of character, the backbone to oppose sudden whims of the people fanned by sensational newspapers.

You will remind me of the *vox populi,* and I agree with you: The *vox populi* is always right, *in time.* If you, by some method or other, make people spare time for sober second thought, if you do just what the strong man in his high position considers his duty to do and does so, then only do you obtain the true *vox populi.* Without the sober second thought, the people's will, the *vox populi,* is no better than mob law.

Look at the record of the Recall: The Athenians banished Aristides, their noblest citizen! The Romans, after a mock trial, murdered Manlius, the man who had saved Rome from the Gauls. The Dutch in the Middle Ages tore de Witt, one of their greatest statesmen, to pieces on the open market place of Antwerp. The Florentines banished their greatest genius, Dante Alleghieri; after sober second thought they recalled him but the proud man refused.

To come down to our own milder times. The good people of Seattle after one of those holy crusades so fashionable nowadays, recalled their Mayor two years ago. After sober second thought, they re-elected him two weeks ago by a majority of 14,000.

To conclude the record and to show that comedy as well as tragedy intermingle in the workings of this freak law, there is now circulating in a Texas town an Initiative Petition for recalling their Recall!

The Recall strikes the strong man, the man of character, not the demagogue with the ear always towards the ground listening for popular notions. It increases tenfold our present difficulty in inducing good men to accept office. It is one of the most pernicious laws ever put on a statute book. As a feature of the proposed new Charter for our City, it is enough by itself to condemn the whole charter.

DISCUSSION.

Mr. Edward Flad. The Board of Freeholders has been laboring for many months in an effort to draft a new charter for

the City of St. Louis. We have been told repeatedly that our efforts would prove futile, that we were merely wasting our time, that the new charter would be rejected by the people. But we have continued with our work resolutely, the Board meeting two and three times per week, with frequent committee meetings to fill up our idle moments.

It is not a simple matter for thirteen men of different minds to come to an agreement on important questions. Each one of us has preconceived ideas in regard to the questions involved. The charter as drafted will not be entirely satisfactory to any one member of the Board, but it will for that reason be a safer and better instrument for the government of the City.

It has been a source of surprise to me to find that on most important questions, the members of the Board have, after a thorough discussion and a weighing of arguments on both sides, come to an almost unanimous conclusion.

Mr. Gayler's paper is opportune. I was aware that he was opposed to the adoption of a new charter and when I learned that he proposed to give his views to the Engineers' Club, I was much concerned lest his arguments might prove unanswerable.

The advance copy of this paper has afforded me much relief.

Mr. Gayler argues that the old charter should be amended and not entirely replaced by a new instrument. There are many fundamental changes required, however, in order to correct defects in our present charter and to fit the charter for the increased activities of a modern city. A change in one direction, a shifting of the duties and responsibilities of one office generally calls for many other changes. It would seem that an harmonious instrument could best be produced by a complete revision, after a careful consideration of the effect of each alteration, in order that the various departments of the City government may be properly co-ordinated, with authority clearly defined and responsibility definitely placed.

Mr. Gayler makes reference to the Commission form of Government adopted by Galveston and the Commission-Manager Plan adopted by Dayton, Ohio. The form of charter proposed for St. Louis, however, is quite different from either of these, so it will not be necessary at this time to dwell upon their shortcomings or advantages. We did not consider either of these

forms of government well adapted to the needs of the City of St. Louis.

Mr. Gayler expresses a preference for two legislative bodies. Therein, no doubt, lies safety but therein also lies inaction and a division of responsibility. Important questions require legislation,—the two bodies, each supreme and independent, fail to agree and nothing is done. The interests of the people suffer but they are helpless. Better an occasional mistake than complaisant inaction. Our free bridge devoid of approaches is a forceful argument against two houses of legislation. One legislative body selected by the people, with a representative for each ward, twenty-eight wards, one representative for each 25,000 people—that is what we propose. A truly representative legislative body.

I yield to no man in my admiration for the work of the Board of Public Improvements. The rules and regulations and the high standards adopted by the first board under our present charter marked out a line of procedure which has happily been followed by each succeeding Board. It is not the form of government, however, so much as the honesty and ability of those who administer, that decides for failure or success.

In the proposed charter the Board of Public Improvements is retained, its duties, its powers and responsibilities are increased. Mr. Gayler holds that the President of the Board of Public Improvements should be elected. I am inclined to agree with him and so voted on the Board of Freeholders. The majority of that Board, however, held that an independent president with all the other members appointed by the Mayor might result in a lack of harmony. That is an argument worthy of consideration.

The five members of the Board of Public Improvements will be appointed by the Mayor, without requiring approval by any other authority. They will be subject to removal, however, only for cause, an important safeguard for officers in whom is vested high authority and responsibility.

Mr. Gayler suggests that we should retain the present plan of allowing the members of the Board of Public Improvements to hold over until the middle of the term of the new Mayor. It is held by the majority of the Board that this plan is apt to result in a lack of harmony. It was thought better to give the

new administration full power to carry out its policies and select its own cabinet at the beginning of its term.

I am pleased to note that Mr. Gayler approves of the adoption of the "merit system." This, to my mind, is one of the most important provisions contained in our proposed charter. The selection of employes on the basis of merit and particular fitness for the duties required and the advancement on the basis of efficient services and demonstrated ability rather than selection and advancement on the basis of political activity or personal favoritism would seem to be a fundamentl requirement for an effective and efficient administration.

Modern cities are taking upon themselves new activities, the ownership and management of various utilities. Without an effective "merit system" such undertakings are doomed to failure, but with a proper merit system, faithfully enforced, the City may safely engage in new enterprises, gradually enlarging its sphere of action, until, guided no doubt by occasional failure, it learns to supply direct on the basis of its own credit and to its own profit, all the reasonable community requirements of its citizens.

Mr. Gayler commends the work of the Engineers on the Board of Public Improvements. In the proposed charter the Engineers are given better representation than in the present charter. At present only one member of the Board, the Water Commissioner, must be "a duly qualified engineer" whereas under the proposed charter at least three out of the five members of the Board of Public Improvements are required to be engineers.

Mr. Gayler objects to the "recall." Under proper safeguards there is but little danger and some possibility of good in the recall.

The proposed charter provides that a petition for the recall of an elective officer must be signed by 20 per cent of all the registered voters of the city at the time of the last preceding regular mayoralty election and by 20 per cent of the registered voters in each of two-thirds of the wards of the city. No petition shall seek the recall of more than one officer. An appointive officer is not subject to recall. The Members of the Board of Aldermen, the Mayor and Comptroller are the only officers subject to the recall. All appointive officers are subject to removal with or without cause by the officers who made the appoint-

ments excepting only the Heads of Departments and Divisions appointed by the Mayor and these are subject to removal only for cause.

Having thus effectually disposed of all of the arguments made by our esteemed member, Mr. Gayler, I am free to confess that I have not entirely convinced myself that all of his objections are without merit. Had I the sole power to decide I would include the following provisions in the new charter:

1. The President of the Board of Public Improvements to be elected by the people.

2. The Mayor to appoint the members of the Board of Public Improvements in the middle of his term, two years after his election.

3. Appointments of the Mayor to be made subject to the approval of the Board of Public Improvements or the President of the Board of Aldermen, as the Mayor may elect.

4. All appointments and removals by Division Heads to be made subject to the approval of the Department Heads.

5. The members of the Board of Public Improvements to act as a body of Directors without having individual responsibility for any particular department.

Whereas the above provisions would represent my individual views I realize that substantial arguments can be made against all of these provisions and I am not disposed to consider them of sufficient importance to warrant serious opposition to the proposed charter on account of their exclusion, in view of the many positive merits which it possesses.

Permit me briefly to call your attention to a few of the provisions in the new charter which should merit special approval.

1. *A single legislative body* which is truly representative, elected by the people from districts.

2. *Non-partisan nominations* and preferential voting to become possible whenever the State laws permit.

3. *Broad Powers for the City.* The City is given the broadest powers possible under the constitution and laws of the State, to construct, acquire, own and operate public utilities of all kinds.

4. *Short Ballot.* In place of voting for a long list of officers as at present, you will be required to vote for only the Mayor, Comptroller, President of Board of Aldermen and one member of the Board of Aldermen, four in all, assuming that the constitution of the State will be altered to permit of the election of the Alderman by districts.

5. *The initiative,* referendum and recall under proper safeguards.

6. Salaries commensurate with the work and services involved.

7. *A merit system* which, if properly applied, should insure the appointment of capable employes and advancement on the basis of efficient services rendered.

8. *Extended powers* to condemn property for public use.

9. *Special Taxes.* More equitable assessment and a limited guarantee of the tax bills by the City, with an effort to divorce, as far as possible, the financial transaction from the construction contract.

10. The concentration of authority and the fixing of responsibility,—important matters being delegated to individual officers controlled by a Board of Officers.

11. Perhaps the most important change contemplated in the administration of the affairs of the Board of Public Improvements is the placing of all engineering work under one Director whose duty it is to prepare all "plans and specifications for all engineering, construction and reconstruction work . . . and supervise all work in which the City is interested and construct all public buildings."* At present each department head prepares plans and specifications for new work. Under the proposed plan the division head becomes an operating officer. Engineering work will be placed in one department with a Director and proper division heads and with power to engage specialists in the designing and planning of important engineering work or architectural structures. Such an arrangement will not of course forbid the utilization of the experience developed in the operating department in the planning of new work. It will pro-

*[Editorial Note: This was changed in the final draft. Vide.]

vide an organization which can be shifted to different lines of work, enlarged or diminished in its various divisions as occasion requires, with the addition of specialists for temporary employment where the importance of the work seems to warrant. An engineer may be a good operating officer and still not be a specialist capable of planning new work of the kind he is operating.

It is proper that the influence of the Engineers' Club should be exerted in framing the provisions of the new charter. Many of our members have served the City in various capacities under the present charter and are familiar with its shortcomings as well as with its many admirable provisions designed especially to prevent the abuse of power as well as to insure a careful and proper consideration of all important questions before final action is taken.

I am quite certain that the Board of Freeholders would welcome suggestions from the Engineers' Club especially in reference to those provisions which effect the engineering work of the City and the organization of the Engineering Department of the city government.

Mr. Edward E. Wall. Mr. Chairman and gentlemen of the Engineers' Club. I do not intend to discuss all the points that Mr. Gayler did, by any means, but only a few of them. His remarks on the recall struck me very forcibly at first, and reminded me of a line of Burns' that:

> "The fear of Hell, is but the hangman's whip,
> To keep the wretch in order."

The recall in the proposed new charter to which Mr. Gayler so strenuously objects is intended no doubt to act as a deterrent and is not expected to be used except in cases of emergency. Such a law could be used with great injustice in some individual cases, just as many of our laws at times work great hardship on the individual. But when we go to the extreme in entrusting great power and responsibility to an individual, is it not perfectly fair to hold in reserve some drastic method of restraint? Mistakes will undoubtedly be made but what is the history of mankind but a story of blunders and crimes, with here and there a gleam of sanity and common sense to lighten the dark record? The actual history of humanity never has and probably never

can be written. But in a word it has been always a struggle upward towards the light. It has been a battle for what each generation believed to be right and just. So always the human race has been moving toward better things, and always there has been opposition not only from the classes enjoying privileges, but also from the masses who could not understand and did not believe that the proposed reforms would result in good. They quarreled over methods just as we are doing to-day. Most often the objectors were right and perhaps not one per cent of the proposed cures for all evils have any practical value. But Mr. Gayler should remember that this is the only way mankind can progress. Nothing is absolute. Everything is relative and we can only approach the ultimate highest good by slow stages, without ever reaching it, just as the asymptote continually approaches the curve without ever touching it.

Just because our present charter has served us well for almost forty years is no proof that a better one cannot be written. I agree with much that Mr. Gayler has said in his paper and I compliment him on his wit and logic. But he admits that representative government is unsatisfactory because we will not all register and vote, and he is opposed to monarchial or autocratic government and also to a "commissioner-manager-director system." So it seems to me that he is going to be dissatisfied no matter what we do. So are many others of our good citizens.

I will agree with Mr. Gayler that our present charter could be so amended as to fulfill all the present needs of our city government. I also agree with him that the general scheme of the administration of public improvements as provided for in the present charter should be retained. In fact the proposed new charter does not change this in essence, but amplifies and extends it. But I cannot entirely agree with the Board of Freeholders in their division of work among members of the Board of Public Improvements.

The most radical defect in the arrangement, to my mind, is the creation of the Director of Engineering and Construction, who is to have charge of *all* designing and construction of all public work.* Without attempting to go into the details of his duties, I will say that I can forsee an endless complication of troubles for him, an eternal conflict between him and the oper-

*[Editorial Note: This was changed in the final draft. Vide.]

ating forces, the practical impossibility of divorcing the maintenance work from the construction, the confusion and necessary duplication of records and the endless disputes over the boundaries of authority of his department and that of others. The idea in creating this department evidently arises in the belief that great economy will result from using the same engineering force on all public work. To my mind this is not true. In this age of specialization, no man can turn at will from the design or construction of sewers, streets, buildings or water works and do equally good work on either, or if he attempts it, it will be equally poor work on all. The same will be true of draftsmen, surveyors, and inspectors. Again if your men cannot do this, no economy will result. In my opinion, each department should be and remain as it is now, a separate entity in itself, with its own organization and its own pride in its individuality. The salaries of the heads of Departments should be raised as well as that of their assistants. They should be provided with more help and greater latitude should be given them in employing competent men at salaries commensurate with those paid by other corporations for similar services.

There are many points in the proposed charter which I should like to discuss, but I cannot undertake to do so in the limited time that I may be allowed this evening. To discuss this document properly and as the Engineers' Club should do it if they conscientiously performed their duty, would require them to hold nightly sessions for a month.

There is the Merit System, Efficiency Commission, Civil Service, or whatever you please to call it. Mr. Gayler endorses it, but I believe we could astound him by the evidence and argument that could readily be brought forward against it.

The administration of a city's affairs is not at all similar to that of a private corporation although many people seem to think so. In the first place private corporations are operated for profit and they exploit the people for their benefit. The municipal corporation is operated without profit and for the benefit of the people. The private company gives as poor service as it dares while the city institution constantly endeavors to improve the service. The people want good service and are willing to pay liberally for it. They do not desire a cheese-paring policy to be practiced by any administration, nor do they wish for reckless extravagance. They want their public institutions to be kept up

just a little better than private ones, so that they can speak of them without apologizing. They are not particularly concerned about the expenditure of a few hundred thousand dollars, provided they feel that they are getting good service. So that in municipal government there is something to be considered besides efficiency and economy, which lately seems to be the slogan of reformers. I could write a paper on this subject alone.

In closing my contribution to this discussion, let me say that we do need a new charter; we will all agree that no perfect charter can be written; that some of us are going to be dissatisfied with whatever is proposed; it is not going to work smoothly if it is passed; we are sure to have trouble in living up to it; but on the whole when we get it and put it into operation, we, as a city, are going to be better off.

[Editorial Note: Much additional discussion of value was contributed impromptu by other members of the Club, but the space available requires that the published discussion be limited to that which was submitted in writing.]

[NOTE.—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

THE NEW CHARTER OF THE CITY OF ST. LOUIS.

[Adopted at a Special Election, June 30, 1914.]

Statement of Principal Features.

By Wilbur B. Jones,
Secretary of the Board of Freeholders.

The Board of Freeholders was elected by the people April 1, 1913.

They at once recognized that the Charter to be drafted was the people's Charter, that the people should be consulted as to what the Charter should contain, and that the voters were entitled to full publicity of every action of the Board. Consequently, through the press by general invitation to every citizen, and by personal invitation to the present and former City officers, to each member of the Municipal Assembly and to the various business, civic, labor, professional, religious, social, political and other organizations throughout the entire City, the Board earnestly sought suggestions and urged their submission, either orally or in writing, to the Board. It also sought and received advice from recognized students and experts on municipal government throughout the United States. In consequence, from April to November, twice a week at each meeting representative citizens and expert students addressed the Board.

In response to a City-wide demand for a correct statement of Charter progress, the Secretary, on February 7, 1914, sent such a statement to the proper officer of every organization, civic, business, labor, etc., listed in the City Directory. On March 5th a tentative draft was published and submitted personally to the head of each administrative branch of the City, asking for criticism and suggestions. Another re-print was published March 30th, and the final draft on April 29th.

Criticism of the tentative work was freely asked and freely given. In many cases the criticism was merited and consequently changes were made. As a result, the Charter is essentially the draft of the people; everyone in the City has had an opportunity to aid in formulating the Charter provisions and many have done so. The important provisions include:

1. The right of municipal ownership of public utilities of any kind whatsoever in the City—a right absolutely denied at

present. The City will have the greatest powers possible, including the right to provide for any desired humanitarian, educational, charitable and recreative service.

2. *One* house of legislation known as the Board of Aldermen. One house and strict ward representation is at present impossible under the Constitution of Missouri (Article IX, Sec. 22). As soon as the Constitution is changed, each ward will elect its own Alderman, but until then it is provided that each ward shall have an alderman who must reside in the ward from which elected, but he will be nominated and elected at large. This legislative body will perform legislative duties only. Such administrative matters as granting permits for awnings, drinking fountains, loading platforms, etc., now granted by the Municipal Assembly by ordinance, will be handled by the Administrative Body, the Board of Public Service, who will be competent administrators and have the time to consider each application.

3. The Initiative on a workable basis—5 per cent of the registered voters for a general election and 7 per cent for a special. The Board of Aldermen will have an opportunity to pass initiated ordinances. If not so passed, the proposed ordinance shall be submitted to the voters.

4. Referendum on ordinances. No ordinance (except strict emergency measures) will take effect for thirty days after adoption, and if within that time a petition signed by 2 per cent of the registered voters is filed with the Board of Election Commissioners the taking effect of such ordinance is postponed. Forty days more are allowed to secure an additional 5 per cent for submission at a general election or an additional 10 per cent for a special election. After the petition is filed the Board of Aldermen have an opportunity to repeal such ordinance. If they do not repeal it, then its adoption shall be submitted to the voters.

5. All elective officers may be recalled. The petition must be signed by 20 per cent of the registered voters, with 20 per cent of such voters in at least two-thirds of the wards of the city. No recall petition may be filed within six months after one takes office. This will prevent such petition being filed immediately after a close election and before the incumbent has had an opportunity to show his worth.

Objection to the recall found in certain Western cities where the successor may be elected at the same time at which the question of the incumbent's recall is determined is obviated. Such an election confuses the issues. Under the proposed Charter the *sole* question will be as to whether the incumbent shall be recalled.

6. The efficiency provisions will require applicants for appointment or promotion to show their qualifications only by such fair and practical tests as will secure and retain in the employ of the City efficient service. All City officers and employes at the time the Charter takes effect will retain their offices and not be required to take an examination therefor. Under the proposed plan, the Efficiency Board may delegate to practical men the authority to test applicants and certify back results in order to insure the best qualified men from a practical standpoint. The appointing officer selects one of the three highest on the eligible list. Elective officers, heads of departments, heads of divisions, and their personal assistants or secretaries, are not subject to the efficiency provisions.

7. The administration of the City will be organized on business lines. The State Constitution provides that the voters of the City shall elect a Chief Executive. Under the proposed Charter the Mayor will *be* the chief executive. He will have power to accomplish results and will be responsible for results being also always under the control of the people through the Recall. Under the present system of checks and balances responsibility is beclouded and cannot be fixed.

The present large number of independent departments and offices is combined according to their functions, so as to insure efficiency and economy in operation. The Mayor, Comptroller and President of the Board of Aldermen, constituting the Board of Estimate and Apportionment, controls the City's purse strings. A separate ordinance for salaries of employes may be submitted separate from the general appropriation bill to prevent the annual tie-up of salaries.

8. Provision is made so that in the largest measure the individual may be kept informed of what is being done in every department—and may have the right to suggest or criticise—and a Complaint Board is established whose duty it

shall be to promptly investigate the complaint of any citizen either with regard to the conduct of the City government or of any public service corporation.

The foregoing is necessarily brief. Many other excellent provisions will be found by a detailed examination of the Charter.

[Editorial Note: Some of the features pertaining to the Board of Public Service, as published in the original tentative draft, were substantially modified in the final draft, partly as a result of Mr. Gayler's severe criticism. As this article is unique in many respects it is believed that it will be of value and interest to engineers everywhere and it is therefore published here in full. Any member of the Association of Engineering Societies who desires a complete copy of the adopted Charter will be supplied by addressing the Secretary of the Board of Managers.]

BOARD OF PUBLIC SERVICE.

Article XIII.

Section 1. There shall be a Board of Public Service, consisting of the President of said Board, and four Directors, who shall be known as Director of Public Utilities, Director of Streets and Sewers, Director of Public Welfare and Director of Public Safety. They shall be the heads of and exercise supervision over their respective departments hereby created, as follows: Department of the President, Department of Public Utilities, Department of Streets and Sewers, Department of Public Welfare and Department of Public Safety. They shall each receive a salary of eight thousand dollars per annum.

Sec. 2. The President of the Board and the Directors of Public Utilities and of Streets and Sewers shall be engineers of technical training, of at least ten years' experience, and qualified to design as well as to direct engineering work.

Sec. 3. Any member of the Board of Public Service may designate any officer in any department under said Board to act as his deputy, but such deputy shall have no vote on the Board.

Sec. 4. The Board of Public Service shall meet at least once each week at its office. The President of the Board shall preside at its meetings. A majority of the Board shall constitute a quorum for the transaction of business, but no final action shall be taken in any matter concerning the department of any absent member unless such matter has been made the special order of the day. Said Board shall furnish through its President to the Mayor and the Board of Aldermen such data and information as may be required, or which it may from time to time deem necessary; prescribe rules and regulations necessary and proper to carry out its functions; appoint a secretary and such other employes as may be provided by ordinance; and keep a record of its proceedings which shall be open to the public. Final action on any matter shall be taken by yeas and nays and entered on its record. An abstract of its proceedings shall be published in the paper or papers doing the City publishing.

Sec. 5. The Board of Public Service shall have power:

(a) To exercise supervision and control over the aforesaid departments and the heads thereof.

(b) To grant permits to occupy or use portions of any public ground, highways, streets, alleys, or other public places, consistent with the public use thereof and not inconsistent with any law or general ordinance, including permits for switch connections, and any such permit may be revoked by said Board at will; but this power shall never be deemed to vest in said Board the right to grant franchises.

(c) To grant permits, according to such general rules and regulations as may be provided by general ordinance, in relation to any private business required by ordinance to have a permit as a condition of or in connection with its conduct or operation.

(d) To accept or reject grants or dedications, absolute or conditional, of highways, streets, boulevards, parkways, alleys or other property for any public use. No plat of any addition or subdivision, or any plat or map attached to any deed, shall be filed or recorded in the Recorder's office unless the same shall first be approved by the Board as to public highways, streets, boulevards, parkways, alleys or other public

places represented thereon, and the grades thereof, except plats accompanying judgments or orders of court in partition and other suits where such plats form a part of such proceedings.

(e) To establish the grades of the center line of all public highways, streets, boulevards, parkways and alleys. Upon demand of the owner of the property abutting on any public highway, street, boulevard, parkway or alley, the Board shall determine the grade of the line of said public highway, street, boulevard, parkway or alley forming the boundary line of such property.

(f) To control and conduct any and all engineering, construction and reconstruction work undertaken by the City, and to supervise all such work in which the City is interested. All plans and specifications for such work shall be prepared under the direction of the Board and be subject to its approval.

(g) To make such recommendations, exercise such powers and perform such duties as may be required of it by this Charter or by ordinance.

Sec. 6. Said Departments shall have divisions as herein established. The head of each department shall appoint all heads of divisions in his department and all officers and employes in his department not assigned to a division. The head of each division shall manage his division and appoint all officers and employes therein.

Sec. 7. All departments under the Board of Public Service shall co-operate, and the employes or assistants in any one department or division may, under the order of the Board, be temporarily utilized by any other department or division. All questions as to the distribution of powers or duties between such departments shall be determined by the Board.

Sec. 8. The Board may at any time, with the approval of the Board of Estimate and Apportionment, appoint specialists or experts in connection with any public work or improvement for which an appropriation has been made and pay for their services out of such appropriation.

Sec. 9. Department of the President. The Department of the President shall have charge and supervision of

all public work and improvements undertaken by the City or in which the City is interested and prepare all plans and specifications therefor, except where such supervision, work or preparation is herein or by the Board of Public Service otherwise assigned or provided.

Sec. 10. Department of Public Utilities. The Department of Public Utilities shall have general supervision over the maintenance, equipment, operation and service, and the assessment of rates and charges, of all public utilities owned or operated by the City. It shall execute or cause to be executed all ordinances regulating the construction, reconstruction, extension, maintenance, equipment, operation, service or rates of public utilities operating under franchises for such service. The Director of said department shall make investigations and reports in relation to any of the foregoing matters as may be provided by ordinance or required by the Board of Public Service, and in connection therewith shall have power to subpoena witnesses and order the production of books and papers relating thereto. He shall have charge of the supervision of City lighting, and of the municipal electric lighting plants and electrical equipment in City buildings.

Sec. 11. There shall be a Water Division in this department and the head thereof shall be known as the Water Commissioner. It shall have under its special charge the operaation and maintenance of the water works and of all facilities for the acquisition and distribution of water. It shall assess water rates as may be provided by ordinance and make out the bills therefor and deliver same to the Comptroller who shall deliver them to the Collector, take his receipt therefor and charge him therewith on the Comptroller's books.

As long as any of the "St. Louis Water Bonds" or renewals thereof or bonds issued on the special credit of the water works or facilities remain unpaid the water rates shall be fixed at prices that will produce revenue sufficient at least to pay the running expenses of the water division and the interest on all such bonds and renewals.

Sec. 12. The accounts of all public utilities owned and operated by the City and dependent for their revenues upon the

distinct from all other accounts of the City, and shall contain proportionate charges for all services performed for such utilities by other departments, as well as proportionate credits for all services rendered.

Sec. 13. Department of Streets and Sewers. The Department of Streets and Sewers shall include street and sewer divisions.

(a) The Street Division shall have charge of the repairing, cleaning and maintenance of all public highways, streets, boulevards, alleys, bridges, wharves and levees; the sprinkling of streets and the collection and disposal of garbage, ashes and refuse, and except as otherwise provided by law or ordinance shall have charge of the enforcement and execution of all ordinances relating to any of the matters referred to in this section or to the harbor.

(b) The Sewer Division shall have charge of the repairing, cleaning and maintenance of all sewers and drains and the disposal of sewage.

Sec. 14. Department of Public Welfare. The Department of Public Welfare shall include divisions of health, of hospitals, of parks and recreation, and of correction.

(a) The head of the division of health shall be known as the Health Commissioner. Said division shall have general supervision over the public health and shall see that the laws and ordinances in relation thereto are observed and enforced, and for that purpose the Health Commissioner is authorized and empowered, with the approval of the Director of Public Welfare, to make such rules and regulations, not inconsistent with this Charter or any law or ordinance, as will tend to preserve or promote the health of the City; to enter into, or to authorize and require any employe or police officer to enter into, and examine any building, lot or place within the City, and to ascertain the condition thereof so far as the public health may be affected by it; and to declare and abate nuisances as herein or by law or ordinance provided. Where, in the judgment of said Commissioner, the existence of a nuisance is plain and its continuance a danger to public health, he may declare such nuisance and danger, and enter such declaration in the records of his office. He shall then

immediately abate such nuisance without notice. In all other cases before abating a nuisance on private property he shall give a hearing, after notice thereof given either personally to the owner or his agent or by posting on or near the premises, whereupon he may declare the nuisance and order its abatement. In case such nuisance is not abated as ordered, he shall abate the same. In case of abatement of nuisance on private property, the cost thereof may be assessed and collected as a special tax and be a lien on such property as may be provided by ordinance. Any person causing or maintaining any nuisance shall be liable to the City in a civil action for the expense incurred in abating such nuisance. Failure to abate a nuisance after an order so to do as aforesaid shall constitute a misdemeanor, punishable as may be provided by ordinance.

Whenever any malignant infectious or contagious disease is prevalent in the City, or will probably become so, the Mayor may proclaim such fact to the inhabitants, and thereupon anything in this Charter or any ordinance to the contrary notwithstanding, the Health Commissioner, with the approval of the Director of Public Welfare and the Mayor, shall have power, until the Mayor shall proclaim that the occasion therefor is past, to take such steps, use such measures and incur such expense as may in the opinion of the Commissioner be necessary to avoid, suppress or mitigate such disease.

Said Commissioner shall keep a record of his acts and orders and shall file in his office all petitions, documents and papers belonging thereto. Copies of such records, petitions, documents and papers when certified by him or as may be provided by ordinance shall be prima facia evidence in any court of the facts therein contained.

All police officers shall observe the sanitary conditions in their districts and, through the Chief of Police, shall report to the Health Commissioner promptly, any disease or nuisance in the City.

The health division shall have charge of the registration of all births and deaths within the City. It shall have charge of the markets, the quarantine and the morgue, and the Health Commissioner, with the approval of the Director of Public Welfare, shall make all necessary rules for the government thereof.

(b) There shall be a Division of Hospitals which shall in-

clude, and have under its special charge and supervision the operation and maintenance of all the hospitals, infirmaries, medical laboratories, dispensaries and other charitable institutions of the city. The head of said division shall be known as the Hospital Commissioner.

(c) There shall be a Division of Parks and Recreation, which, except as may be otherwise herein or by law provided, shall have supervision and control of all public parks and places and of all facilities provided by the City for recreation, amusement or instruction, and execute all ordinances of the City relating to the management or use thereof. It shall also exercise such supervision and control as may be provided by ordinance over public recreative functions, amusements and entertainments not conducted by the City. The head of said division shall be known as the Commissioner of Parks and Recreation. He shall appoint and control the City Forester.

(d) There shall be a Division of Correction, which shall include and have under its special charge and supervision the operation and maintenance of all detentive, penal and corrective institutions of the City. The head of said division shall be known as the Commissioner of Correction.

(e) The Board of Aldermen may by ordinance include in the Department of Public Welfare and make provision: for research and publicity concerning the causes of poverty, delinquency, crime and disease, or concerning other problems relating to the public health, morals and welfare, and to promote the education of the City with regard thereto; for free legal aid; for a municipal lodging house; for a City free employment bureau; and provide for such officer or officers in charge thereof as may be necessary.

Sec. 15. Department of Public Safety. The Department of Public Safety shall include the following divisions:

(a) When the City is permitted by law to establish and maintain a police department, such department shall be a division hereunder. The head of said division shall be known as Police Commissioner. He may be removed, with or without cause, by the Director of Public Safety or by the Governor of the State.

(b) When the City is permitted by law to establish and maintain an excise department, such department shall be a

division hereunder. The head of said division shall be known as Excise Commissioner. He may be removed, with or without cause, by the Director of Public Safety or by the Governor of the State.

(c) There shall be a division of Fire and Fire Prevention which shall manage, control and conduct the fire department, and take all proper steps for fire prevention or suppression. The head of said division shall be known as Chief of the Fire Department. In case of emergency, with the approval of the Director of Public Safety, he may purchase or hire whatever may be required for the emergency, with or without authority or appropriation by ordinance therefor. He or any assistant in charge at any fire shall have the same police powers at such fire as the Chief of Police, under such regulations as may be prescribed by ordinance. He may appoint a Fire Marshal, whose duty it shall be, subject to the Chief of the Fire Department to investigate the cause, origin and circumstances of fires and the loss occasioned thereby and assist in the prevention of arson. The Chief of the Fire Department shall have charge of the fire and police telegraph and telephone systems.

(d) There shall be a division of Weights and Measures which shall execute all ordinances regulating or relating to weights and measures or the inspection thereof. The head of said division shall be known as the Commissioner of Weights and Measures.

(e) There shall be a division of Building and Inspection. It shall superintend all buildings belonging to or under the control of the City and have charge of the condemnation of unsafe buildings and the prevention of the use of buildings while unsafe, the granting of building permits, the inspection of all buildings in course of construction, the enforcement of all building ordinances; the supervision of all plumbing; the abatement of the smoke nuisance; and the inspection of all boilers, elevators and mechanical plants. The head of said division shall be known as the Building Commissioner.

COMMENDATION FROM THE KANSAS CITY STAR.

Under the caption, "Good for St. Louis," the Kansas City *Star,* on July 1st, contained the following editorial:

"By adopting an effective, progressive Charter St. Louis has

taken a big step forward. No other city can now point scornfully to St. Louis as a self-satisfied bourbon city. It has taken its rank with the forward-looking, forward-moving great cities of the country.

"The Charter gives power to a few officials, tempered and safeguarded by direct responsibility to all the people. It provides the 'short ballot' (except for its comparatively large Council) ; the City Council is composed of one house, and the voters are given the initiative, the referendum and the recall. While the one house of the Council has twenty-eight members, all of these are to be elected by the city at large.

"This Council arrangement, with the large administrative powers given to the Mayor and certain provided boards, marks something of an experiment in municipal government. But the principles of direct responsibility and defined power that are applied to all departments give good assurance that these experimental features of the Charter will work well.

"A Board of Public Welfare is one of the new features of this excellent new Charter. The board is given large powers modeled on those of the Kansas City Welfare Board.

"For many years St. Louis has suffered from the political interference of privileged corporations and the allied or subservient business interests that such corporations controlled. These same corporations and business interests fought the Charter. They wished the old Council system; they wished to continue doing city business with the bosses and politicians, rather than with the people and with a government directly responsible to the people. They wished St. Louis to continue 'corrupt and contented.'

"But the revolt of the citizens was too strong. Their education in machine-corporation control had been too severe. Their citizenship was too patriotic and enlightened.

"Good for St. Louis! It has made a hard, persistent fight for freedom and won!"

[NOTE.—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

OBITUARY

WILLIAM A. HUNICKE

Member of the Engineers' Club of St. Louis.

William A. Hunicke was born at St. Louis, Mo., February 23, 1875, and lost his life in the Missouri Athletic Club fire on March 9, 1914.

He attended the St. Louis Public Schools until 1889 and then studied in Germany for three years, returning to St. Louis and graduating from Washington University in 1897 with the degree of B. S. C. E.

His first employment was with Mr. Robt. Moore and Prof. J. B. Johnson, after which he spent five years with the Mexican Central Railroad, in charge of location and construction of their various branch lines. Returning to St. Louis he was placed in charge of the Washington University buildings and the laying out and improvement of the University grounds.

Mr. Hunicke was Assistant Engineer of the St. Louis Terminal Railroad during the time that Mr. Taylor was Chief Engineer, and in that capacity had charge of the relaying of the track in the tunnel, which work had to be accomplished without interference with the traffic. His next work was the location and construction of the extension of the railroads owned by the Sligo Furnace Company in Missouri.

From 1909 to 1911 he was Chief Engineer and Superintendent of Construction of the Appalachicola Northern Railroad, locating and building said road from Appalachicola to Jacksonville, Florida.

From 1911 to 1913 he was Superintendent of Construction for the English Syndicate in Cuba on various extensions of their roads, returning to St. Louis in August, 1913, to become Assistant Operating Engineer of the Missouri Pacific Railroad, which position he held at the time of his untimely death.

He was a member of the American Society of Civil Engineers, the Engineers' Club of St. Louis, the Railway Club of St. Louis, and of the Missouri Athletic Club where he made his home, enjoying its comforts and environments and becoming one of the victims of the holocaust.

He was one of the best posted authorities on railroad location, construction and valuation and was consulting Engineer for a number of the smaller railroads of the South on valuation work.

Beloved by his friends, his was a life well spent in constructive work, and we, who knew him well, cherish his memory.

LEO C. DZIATZKO.

JOHN BICE TURNER

MEMBER OF THE ENGINEERS' CLUB OF ST. LOUIS.

John Bice Turner, a prominent Engineer Contractor, senior member of the firm of John B. Turner and Company, died June 2, 1914, at St. Luke's Hospital, in St. Louis, Missouri.

He was knocked down by an automobile while trying to board a street car, sustaining injuries which resulted in his death less than two hours after the accident. Mr. Turner was a son of the late General John W. Turner and Blanche Soulard, both prominent St. Louisans whose families were conspicuous in the history of St. Louis. Mr. Turner was born February 28, 1880. His early education was obtained in private schools in St. Louis. He entered the Manual Training School in St. Louis in 1894, from which he was graduated in 1897. The following year was spent at the Western Military Academy at Alton, Illinois, preparing for the Massachusetts Institute of Technology where he entered in the fall of 1898. He completed the course in civil engineering and was graduated from that institute with the class of 1902.

Immediately after graduation he was appointed Assistant Engineer in the Water Department of St. Louis, which position he conducted with much credit. He resigned therefrom in 1904 to accept the position of Mechanical Engineer in the Granite City plant of the American Steel Foundries Company, where he remained until the latter part of the same year, and until an attractive offer called him to the position of Assistant Superintendant of the Scullin-Gallagher Iron and Steel Company of St. Louis. This position Mr. Turner held until the spring of 1907, when he entered the field of "engineering contracting" under the name of John B. Turner and Company, Contracting Engineers, his purpose being to specialize in concrete work. Mr.

Turner gained much prominence in this field and as a result of his successful execution of contracts intrusted to his care secured an enviable reputation not alone among the clients whom he served but among engineers, bankers and business men.

Mr. Turner leaves a wife and two boys.

To those dear to him, we extend our sympathy and condolences. His career, though short indeed, gave promise of a brilliant future.

His was a noble life, honestly lived, and in that he leaves a heritage few could surpass.

The Engineering profession has lost a companion in whom centered, to a remarkable degree, those qualities of character that excel by comparison and make the possessor respected and admired by all who were fortunate enough to have known him.

E. H. Abadie.

ASSOCIATION ENGINEERING SOCIETIES

ORGANIZED 1881.

Vol. 53. AUGUST, 1914. No 2

EDITORIAL

Why is a local engineering society and how should it be operated? What benefits should be derived from a local engineering society? What does a man expect when he joins a local engineering society?

These questions and others are touched upon briefly in this issue in a heart-to-heart talk by the Secretary of the Oregon Society to the members of that organization. They are of vital interest to every society in the Association and to every member in each society.

To what extent and in what ways should the social features be combined with the technical? What do *you* expect the society to do for *you* in return for your annual dues? Are you satisfied with the way in which your society is run? If not why not? Put your ideas in writing and send them to *your* Journal for publication. To stay at home because you do not like the way in which your society is run will help neither the society nor yourself. The officers of each society, would like to know the views of its own members and each society would like to know of the success or failure of particular features in other societies. In every community there are many engineers who are not members of the local engineering society. Some are members of national societies while others are not affiliated with any professional society. Possibly a change in policy may bring many of these into your society to the mutual advantage of both.

It is noted in Mr. Stanley's paper that the Oregon Society is provided with a meeting room in the Public Library, at no expense to the Society, and that they also have at hand a much better reference library than they could hope to build up in many years. Here are two suggestions that may mean many dollars to some other society. In fact the success or failure of a society may hinge on these two questions.

It has been found more difficult than anticipated to induce additional societies to join our Association. In the belief that this difficulty could be reduced considerably by eliminating the entrance or initiation fee of 50 cents per member, required by the Articles of Association, the St. Louis Members of the Board of Managers on July 1st submitted to the full Board an amendment providing for this change.

The proposed amendment was acted upon favorably by all of the Board Members who voted. Two members neglected to vote.

This amendment has now been submitted to the societies forming the Association in accordance with Article VI, and in order to become effective must be approved by two-thirds of the participating societies.

The initiation fee is the equivalent of charging 50 cents extra for the first year's subscription to the Journal. So far as we know, no other publishers are now working under such a handicap. The common practice is to offer the first year's subscription at a reduced price,—in some cases at half the regular price. In other cases substantial premiums of many varieties are offered to new subscribers.

No new societies have entered the Association this year but several have given the matter serious consideration, and it is believed that with the removal of the entrance fee, a favorable decision will be reached in some cases.

It is hoped, therefore, that the constituent societies will support the Board of Managers and approve the proposed amendment.

The Secretary has not met with great success in securing new advertisements but invites attention to three, viz., Bausch &

Lomb Optical Co., Webster's New International Dictionary, and the Robert W. Hunt & Co. Bureau of Inspection and Tests. We apprehend that this reference to advertisers will meet with the disapproval of some of our members, but it is done advisedly, because it is so continually asserted that the members pay no attention to the advertisements. The members can render their Association a valuable service by mentioning the Journal wher writing to advertisers, and better still by sending in an advertisement. If you have never noticed the reduced rates "have a look."

THE LOCAL ENGINEERING SOCIETY.

By Orrin E. Stanley,
Secretary of the Oregon Society of Engineers.

[Read before the Society, June 25, 1914.]

As my principal equipment for public speaking consists of a full compliment of cold feet and wobbly knees, it is necessary for me to reduce to writing anything that I wish to say in public. I have therefore noted down a few points that have occurred to me in my work as secretary, which may be of interest to the rest of you.

The question that comes to mind most frequent is: What does a man expect when he joins an engineering society? In other words, what do *you* expect the society to do for *you* in return for your annual dues?

From talking with some of our ex-members, I have been led to believe that they expected upon being admitted to the Society,-to be boosted into immediate affluence; to have a Journal bearing upon their particular branch of the profession come and read itself to them; to have addresses by eminent men, also in their own branch of engineering, profusely illustrated, and served with refreshments; and this, on some evening when they can find no other place to go.

Some of these men have attended the monthly meetings regularly; some have even been heard upon the floor on various occasions, but the greater number have assumed the attitude of "watchful waiting" that has won so much fame for our chief executive.

The officers of our society are listening anxiously for suggestions from any member who believes that he knows some way in which the society may be made of more benefit to himself. And, if at all possible to adopt such views, stands ready and willing to do so.

Most of you remember our brief unprofitable venture in the Technical Club rooms. Believing that the members craved more of the social life than they were getting in the regular meetings. the executive board risked our financial reputation by entering into a contract with the Architect's Club for the joint use of its rooms. It is safe to say that not more than two men a month made any use of the rooms, other than to attend the regular

meetings. After six months the plan was abandoned and arrangements made to hold our meetings in this room (Room "A" of the Public Library), which we are getting at no expense; and besides, we have at hand a much better reference library than we could have hoped to build up in years, in an independent home.

True, we are not allowed to smoke here, and spit upon the walls, but there are few among us who will be permanently injured by refraining from these manly pastimes for the short period of two hours a month.

Then there is the matter of the Journal: If you have paid your dues, and are not getting the Journal of the Association of Engineering Societies, something is wrong, and you should tell your troubles to the secretary. That is what you have a secretary for.

Maybe the Journal does not have the class or the number of articles that you think it should. Do you know why? It is because the constituent societies of the Association are made up of men similar to ourselves—men who are too busy with their own private affairs to write papers for presentation before the societies—men who have never done anything worth while, and are afraid that someone will find it out—or having done something, are too modest to tell of it, or unwilling to face the possible criticism of other engineers.

It is only through criticism and discussion that we advance. No one man can sit in his office and evolve the last word in engineering design, even though he be at the head of his profession. Even his office boy may give him a hint that will be of great value to him. How much greater value, then, will be the criticism of his equals.

Another feature of the meetings that has been neglected to some extent in the past, is the opportunity for meeting and becoming better acquainted with our professional brothers.

How many of you, for instance, can name half of the men in this room, and tell what each can do best? Who among you could advise a client in the selection of an engineer for some line of work with which you are not personally familiar, and feel that his part of the work would be carried on as well as your own?

This meeting with other engineers is perhaps the most valuable factor of membership in the society. The benefit to be de-

rived from such association is difficult to determine. It cannot be measured by so many dollars a year, and it depends largely upon the personal equation of each member. But, in any case, it cannot be sent home to you in a bottle, to be applied at bedtime, or to be taken before meals. You must come to the meetings to get it, and when here you must *mix*.

Engineers are, as a rule, too reserved. They do not exhibit their good points to advantage. Our society is a good place to begin this kind of advertising. And a good way to follow it up, is to insert a professional card in the new society directory which is soon to be published. Tell us what you can do best. And keep on telling the same thing until we all know you by that sign.

If you are a land-clearing engineer, say so. Then when we hear of a clearing job, or see a piece of logged off land, we will think of you.

If your specialty is devolping inventions, tell us about that. We may hear of some one who wants an invention perfected and patented, and we will be most likely to recommend that man whose name we have most strongly and favorably associated with that class of work.

If you do everything equally well—say so if you wish—but we will be inclined to doubt your word and will most likely take our work to a specialist in some one line.

We also have an employment register. About fifty members have signified their willingness to consider offers of employment other than that in which they are now engaged.

Occasionally one has been placed in a better paying or more congenial position. Frequently we have helped an engineer to locate a good assistant. But this branch of the society's activity cannot flourish without the support of the members. Those who will consider a change of employment must say so, and those in need of assistance must ask the secretary for help in locating the man. Only through use by all will this branch of work reach its greatest usefulness.

The Programme Committee will appreciate some help from you, too. If you have done something at some time in your life, write a paper about it. Tell the Programme Committee that you have this paper ready, and that you are fairly aching to give the society the benefit of your genius.

The committee is wise, yes, brilliant, but even so, it has no divine powers which enable it to fathom your inner conscious-

ness and know what you can do. It is up to you to come to the front and offer to do something. You will get a hundred times the benefit from one such effort, than from simply being "among those present."

We keep our education by giving it away, and can best improve ourselves by giving the benefit of our experience to those who have not had our advantages for observation.

Another growing feature of the work of the society is in a capacity advisory to the various public bodies.

The City Commissioners have asked for committees to help consider different subjects; the City Civil Service Board has asked for a committee to act with it in conducting engineering examinations and in classifying the engineering positions in the city service. The State Board of Higher Curricula asked for, and received assistance in outlining courses of engineering study in the two State schools. The Greater Portland Plans Association requested a committee to act with it, and one has been named.

The work on these committees requires considerable time and effort from those appointed, but the work they do is for the general good of the community; and perhaps the greatest benefit is derived by those thus engaged, as a direct result of the efforts they put forth.

Maybe you don't agree with these ideas.

Then give us some of your own. That is what we want.

And come to the meetings whether you think that you will be interested in the subject or not. Ten to one you will learn something that will later be of benefit to you, and which will broaden your field of interest. And if you can do nothing better than sleep through the programme, the relaxation may be just what you need to fit you for the morrow's toil.

Engineers are, as a class, poorly paid because they are poorly advertised, and this, because they are poorly organized.

Therefore, get really into the spirit of the society. Reserve one night in the month for your profession; and come to the meetings.

[NOTE.—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

THE MANUFACTURE OF IRON AND STEEL.

By Charles McGonigle,
Member of the Oregon Society of Engineers.

[Read before the Society, June 25, 1914.]

The subject which I have decided to discuss, if properly and thoroughly covered, would take much longer time than is allotted to all the speakers this evening. In fact, any branch of the great industry would require the whole evening to do it justice. I have in mind the manufacture of steel and iron and will touch in the briefest possible manner on the various processes through which a piece of steel or iron passes from the time it is taken from the earth in the shape of ore until it is placed in the framework of one of the structures with which we are all familiar.

Combinations of iron and carbon are divided into three classes, viz., cast iron, wrought iron and steel, depending upon the amount of carbon contained. Cast iron is a composition of iron and from 5 to 2 per cent carbon; steel contains 1.5 to .1 of 1 per cent and wrought iron contains from .3 to .05 of 1 per cent. The physical properties of these three are well known. Cast iron is hard and brittle with little or no elasticity, wrought iron is not very hard and is tough and elastic, while steel is intermediate between them and possesses the better qualities of both. In a general way the carbon content determines the hardness and elasticity. The more carbon contained, the harder the material, and the less carbon the tougher the product will be.

Historically, wrought iron is much older than the other two. It has been used for weapons of offense and defense, and for utensils since the advent of authentic history. It is mentioned by Homer and in Genesis 4:22 reference is made to Tubalcain, an artificer in brass and iron. Examples have been discovered and preserved that must have been produced about 4,000 B. C. This early wrought iron was produced by the direct process, with a very rich iron ore and by means of charcoal as a fuel. Cast iron was first used in Germany about 1,500 A. D. There is some doubt as to the exact time. The manufacture of steel is comparatively recent. The Bessemer process, from which most of the steel used during the past 25 or 30 years was made, was invented by Sir Henry Bessemer in England in 1856. The most recent method of producing steel, the Open Hearth process, the method that is to-day replacing the Bessemer process, was in-

vented in 1878. Both processes are very generally used to-day for steel for buildings and bridges.

Iron ore is commonly distributed throughout the world and appears in the strata of several different geological ages. Deposits of sufficient size for commercial use have been mined for years in many of the European and Asiatic countries, and in this hemisphere large beds of ore are found in many of the South American countries and throughout the United States. Most of the ore that is used in the manufacture of iron and steel in our largest steel center, Pittsburgh, is mined in Michigan and Minnesota. It is shipped by rail to Duluth, and there transferred to large ore carrying vessels which ply between that port and Cleveland, Ashtabula and Conneaut along the Southern coast of Lake Erie, where it is again transferred to cars and shipped by rail to Pittsburgh. The questions that immediately arise are, why should all this ore be shipped to Pittsburgh with the great expense and trouble; why are the manufacturing places located so far away from the source of supply, and why do they not transfer the mills for manufacturing steel to the mines? One answer to these questions is that the coke, which is absolutely necessary for fuel in the manufacture of iron and steel, is made from coal mined in the neighborhood of Pittsburgh.

Coke is very light and brittle and depreciates rapidly in shipping. The coke which is used in steel manufacture must remain in large pieces, because if crushed to a powder it will not properly support the charge of limestone and iron which is placed above it in the blast furnace. These large pieces are necessary because the heat must pass through the interstices in order to properly melt the ore. The coals from the Pocahontas District of West Virginia and from the Connelsville District of Pennsylvania, both very close to Pittsburgh, are considered among the best coking coals in the world.

The absence of a coal that will properly coke is one of the main reasons why the production of iron and steel has not been successful on this Coast. I understand that there are a number of large ore deposits that would reduce very well if the proper fuel were to be had. With the present methods of reducing iron ore to iron and steel, coke is necessary for the reason that other forms of fuel contain too much sulphur. Sulphur and hot iron have a great affinity for each other, and there is no known method that is practicable for removing the sulphur from the iron.

Therefore it is essential that the fuel used should contain little or no sulphur. Reduction of iron ore by the electric furnace is being studied, but has not yet reached a large commercial stage.

The first reduction of the ore takes place in the blast furnace. Blast furnaces are approximately 90 ft. high, cylindrical in shape and about 20 ft. in diameter, with a conical bottom and a bell-shaped top. This bell-shaped top is used to retain the heat of combustion and also to retain the gases which are used for heating the blast. The bell is movable so that it can be removed when the charge is entering the furnace. Besides the stove proper, the blast furnace requires a number of appliances and buildings for properly handling the material, ovens for retaining the blast heat and engine rooms for pumping and forcing the blast, etc.

This 90 ft. in height of blast furnace is kept practically full of charges at all times. Each charge is composed of three layers, the lower layer is coke for fuel, then the limestone for the flux to assist in removing the iron from the ore and above the limestone comes the ore. After the blast furnace is once lighted, it is kept in continual operation until it needs repairs. Sometimes it is kept lighted for more than a year. The charges are poured into the furnace at the top and at regular intervals the furnace is tapped at the bottom and the iron allowed to run into sand moulds or iron moulds forming the pig iron.

At the time of the cast, i. e., when the furnace is tapped at the bottom, the impurities, which are almost half of the iron ore and also the residue of the limestone, which was used for the flux, must be allowed to run off. These impurities being much lighter than the iron float on top of the charge, and as all the iron has run into the moulds they are deflected into other channels and are transferred to the slag pile. In many of the Eastern States this refuse of the slag is used in making cinder concrete, and it has also been extensively used for railroad ballast. The latter use, I think, has generally been discontinued on main lines because the slag crushes readily and produces a great deal of dust.

Pig iron is only an intermediate step in the production of iron or steel. It is not commercially used in that shape. As pig iron, it is transferred to the Open Hearth, Bessemer or Crucible Furnaces where it is melted and again worked upon until it arrives in the shape in which it is to be used.

Wrought iron has been replaced to a great extent by steel for the reason mentioned before, i. e., the superior tensile and compressive strength of steel. However, wrought iron is still used in the manufacture of sheets and other shapes where soft flexible material is required. Before the introduction of the Bessemer Converter, it was used very generally for the same purposes that steel is put to to-day, i. e., rails, bridges and building members, though it has been discontinued for those uses for about 30 years. The pig iron, to be used in the manufacture of steel, is sent to the Open Hearth Furnaces or the Bessemer Converters and is placed in these furnaces with proper additions of scrap, spiegeleisen, etc., to give it the proper proportions of iron, carbon, phosphorus, etc. After being heated in these furnaces, it is tapped into large ladles, carried by locomotive cranes and poured into moulds forming ingots, which are passed through many sets of rolls forming I Beams, Channels and many other shapes.

During the past ten years the Open Hearth process of steel manufacture has been rapidly replacing the Bessemer process and while the physical and chemical properties of steel from both of these processes may be the same, from experience and examination it appears that the steel manufactured by the Open Hearth process is more uniform and reliable than that produced by the Bessemer process. The reason of this has not yet been determined, at least it is not generally known. It is true, however, that a higher phosphorus ore can be used in the Open Hearth process than in the Bessemer and still produce a low phosphorus steel, phosphorus being a serious impurity in steel used for structural purposes and generally restricted to not more than .1 of 1 per cent.

When the structural engineer prepares the design for a steel building or bridge he specifies the size and shape of the members entering into the framework or construction. The contractor for the fabrication of the steel (this process of fabrication is generally done in a different plant from that which rolls the material) prepares a list of all the materials and forwards this list to the rolling mills and each piece of steel for the entire structure must be ordered and cut to the proper length while it is hot. Very often it is necessary to make the different members out of one or more of the rolled shapes as they come from the mill. This process of cutting steel at the mills to the exact length

required in the building effects a great economy in the work, because if the pieces were rolled in full 60 ft. lengths much waste would result in the subsequent cutting in the fabricating shop and the cutting would also be more expensive. The mills generally reserve the right to cut the steel within three-fourths of an inch of the length to which it is ordered. This ordering of the material before the details are prepared is one of the most interesting and exacting works which is required of the detailers of structural steel. They must decide on the details before they are prepared, and it must be done very accurately. Then while the steel is being rolled at the mills, the fabricating shop prepares the details for the work, and in this way makes a saving in time. In seasons when the steel trade is normal, the mills of the country need from two to three months in which to roll the materials, which time would be wasted if the materials were not ordered ahead of the detail drawing, and it takes about the same time to prepare the details for any large building. Men who are not acquainted with the structural steel work do not realize the great amount of work required to prepare the details for a large building. I have seen 50 engineers and draftsmen working continuously for six months upon the details of one large building and most of the large steel fabricators keep a force of from 50 to 100, and even more, engineers and draftsmen employed preparing details. The details are then sent to the fabricating shop and the material is laid out, punched, drilled, milled and rivited together, depending upon the use to which the different members are put. There should naturally be very little cutting, because, as mentioned before, this cutting to length is done at the mills while the material is hot.

The question of transportation then arises in the case of material used on this Coast. Prior to about six or seven years ago, practically all the steel used on the Pacific Coast was transported from Pittsburgh by rail. It is true some of it was shipped by boat around the Horn. About six years ago the Mexican Central Railroad and the American-Hawaiian Steamship Company formed an agreement and since that time much of the steel for this Coast has been transported by boat from New York to Coatzacoalcos and from that point by rail to Salina Cruz and then by boat to Portland, making the trip in about 40 days, the freight rate by water being much less than by rail, although the time is a little longer in the good season, i. e., in the sum-

mer seasons. In the winter and spring months, during wash-outs, better time was often made by water than by rail and the service was more reliable. Most of the steel for the large buildings built in Portland during the past five years has been brought here by water, and water shipment will increase with the opening of the Panama Canal.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

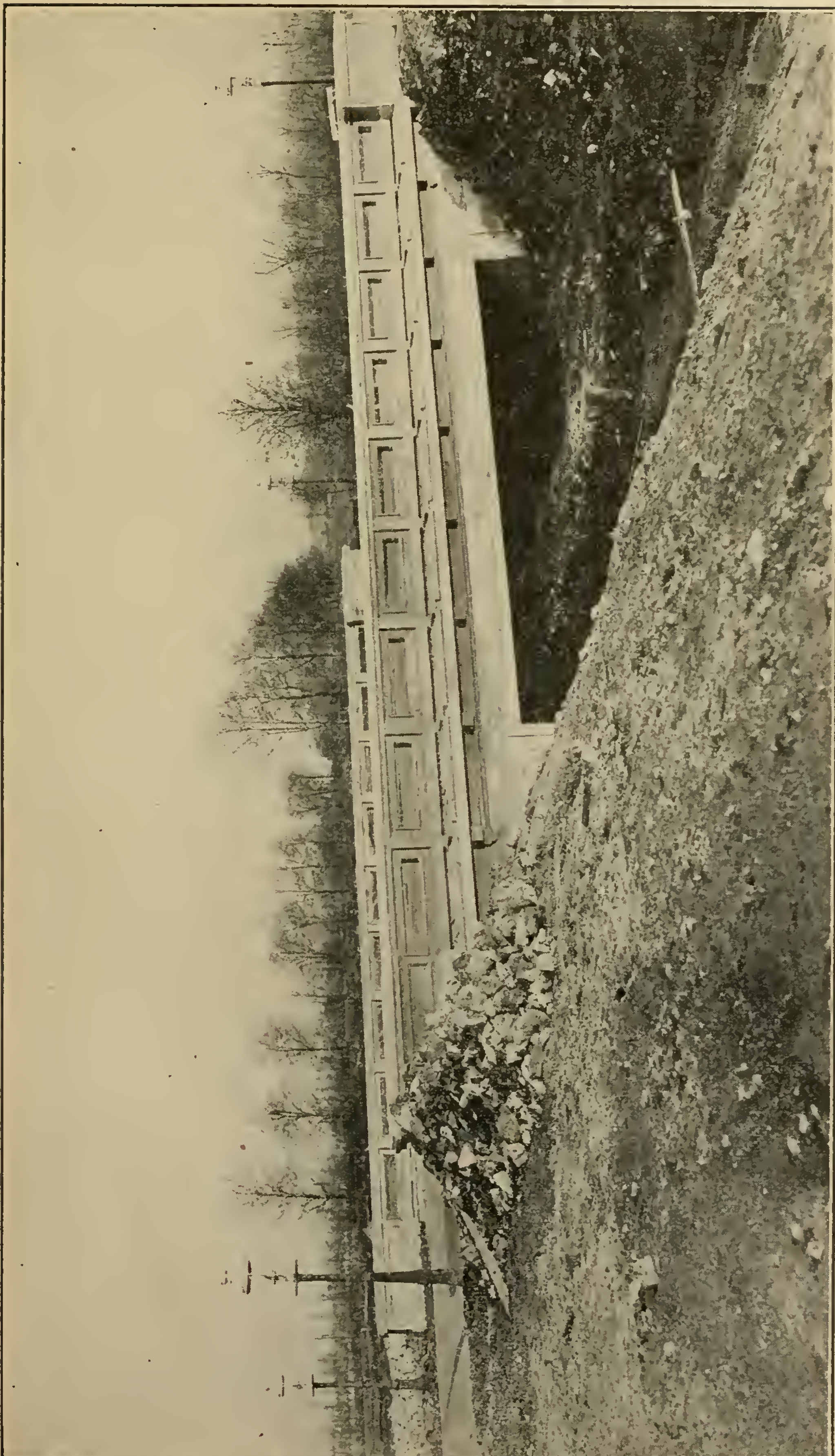
THE DEVELOPMENT OF A UNIT COST SYSTEM.

By Nelson Cunliff,*
Member of the Engineers' Club of St, Louis.

[Read before the Club, April 1, 1914.]

Probably the most important article in an Engineer's equipment should be his unit cost system. The contractors and engineers of recent years have based their estimates mainly on guesswork. This has brought the contracting profession to be looked on as one of the most hazardous of occupations. Our scientists and engineers, by long and tedious investigations, have worked out definite theories and formulas for nearly everything that exists, but have neglected to take into account our contractors. In as much as these scientists and engineers are not working out theories and formulas for the contractors it behooves us to evolve records of our own. With this in mind the Park Department of the City of St. Louis has undertaken to work up a system whereby we may have a correct record of the unit cost of every item of work we perform. As a preface to my description of our cost keeping system I would like to define just what is meant by cost keeping. For the purpose of discussion a distinction must be drawn between bookkeeping and cost-keeping. As Mr. H. P. Gillette tells us in his book of Cost Data, "Bookkeeping is a process of recording commercial transactions for the purpose of showing debit and credit between different accounts. These accounts may be individuals or firms or they may be arbitrary accounts—the latter being an evolution in bookkeeping that came after individual accounts became so large or so complicated as to be insufficient to show the status of the business and the profits derived from any given transaction. Cost-keeping is the process of recording the number of units of work and the number of units of materials entering into the production of any given structure or into the performance of any given operation. To the unit of work or materials actual or arbitrary wages or prices may or may not be assigned. The object of cost-keeping is primarily to show the efficiency of performance; hence actual money disbursements need not be recorded as in bookkeeping. Bookkeeping was first devised and subsequently developed by merchants. Cost-keeping was devised and developed by engineers. The merchant is a student

*Superintendent of Construction, St. Louis Park Department.



Example of Construction Work in St. Louis Park Department.

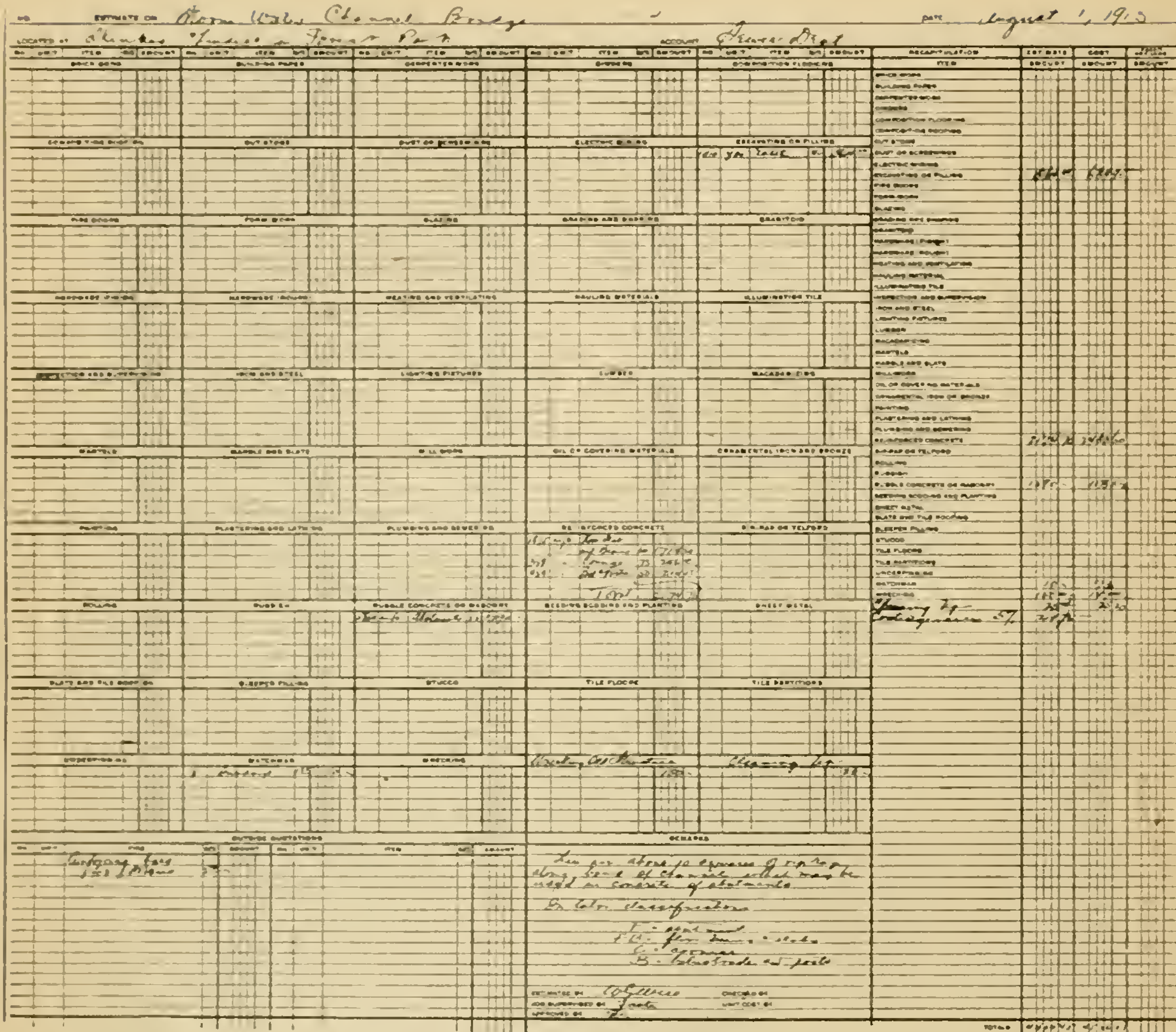


Fig. 1. Estimating Sheet.

of profits: the engineer is a student of costs. Although profits depend upon costs, there is a vast difference between the merchant and engineer."

In the development and application of a cost system an engineer endeavors to divide his work into units upon which his estimates were based; and these units are again divided into subdivisions which will probably show every general step which was taken in the performance of that unit. This work entails certain measurements and calculations which must be made by the engineer and which in the past have been turned over to the bookkeeping department. The bookkeepers have taken this information from the engineer and have endeavored to combine bookkeeping and cost-keeping under one head and have developed a wonderfully complex system.

Such was the case when the system evolved by the Hon. Peter White was turned over to the Park Department. Mr.

White an expert public accountant of national reputation, worked out for the different departments in control of municipal affairs, a bookkeeping system that would simplify and clarify all the records which must necessarily be kept to show the receipts and disbursements of all funds used in the running of a municipality. This system has a great many very good points. It has brought the records and books up to a higher standard and has arranged all data so that it is much more easily understood. However, this system has not been able in any way to furnish us with accurate cost data. Realizing this condition, Mr. Dwight F. Davis authorized his construction division to prepare a cost data system that would serve their purpose to the best advantage. After very careful analysis of our needs we decided that we would require five general sheets upon which to place all data received concerning the different kinds of work we might endeavor to construct. These sheets would be as follows:

Fig. 1. Estimating Sheet.
Fig. 2. Foreman's Daily Report.
Fig. 3. Labor Cost Distribution.
Fig. 4. Labor and Material Cost Distribution.
Fig. 5. Appropriation Register.

The estimating sheet as shown on the accompanying photograph (Fig. 1) will indicate the quantities as they are taken from the plans; the units adopted for arriving at the total estimated cost; proposals or bids of outside firms and any notes as to quality or nature of the materials to be handled. This sheet is similar to a contractor's proposal or bid. After we have made it out, and it is signed by the superintendent, it is given to the Park Commissioner, who accepts or rejects the bid When the bid is accepted we commence work.

From the time the foreman starts work he keeps a record which he turns in on blanks known as the "Foreman's Daily Report." (Fig. 2). This report sheet tells us 17 conditions as follows:

1. The location of the job.
2. The character of the job.
3. Date of the report.
4. Kind of weather.
5. Name of the foreman.

6. Kind of work done and later classification.
7. Total hours of labor under each class.
8. Rates per hour.
9. Total pay.
10. Number of units of each class of work done.
11. Units of materials and supplies used.
12. Units of materials received.
13. Units of materials in stock.
14. Delays, time and cause.
15. Time machines are actually working.
16. Kind of machine or tool used and its condition.
17. Remarks.

The foreman does not have to use all of these blanks but

·PARK · DEPARTMENT·

·PARK· Forest ·DATE· Aug. 29-1913

·JOB· Storm Water Channel Bridge ·WEATHER· Clear ·TEMPERATURE· 90°

·MAN NO.	·NAME·	·OCCUPATION·	·TIME·	·AMOUNT·	
	John Foster	Labor.	10	2	00
	Jerry Byrth	sk lab	10	2	50
	C Hildebrandt	lab	9	1	80
	Chas Feiner	team	10	5	00
	Rob Smith	lab	10	2	00
	Paul Henig	"	10	2	00
	Geo Ray	"	10	2	00
	Wm Eyre	carpenter	8	5	00
	Al. Colvin	lab	10	2	00
	Wm Riebeling	"	10	2	00
	Gottlieb Katz	concrete foreman	7	4	90
	A. Flowers	blockman	7	3	15
	Chas Lavereze	mixer	7	2	80
	John Oranio	"	7	2	80
	Jake Melber	"	7	2	80
	P Kuntz	blockman	7	3	15
	Ben Cunliff	sk lab	10	2	50
	Martin McDonald	lab	10	2	00
	Paul Bomruto	"	5	1	00
	Pete Vivonetto	"	5	1	00
	Al Hewitt	carp. foreman	8	5	[illegible]
	C. Eilert	mixer	7	2	80
	C William	water boy	10	1	00

·I· CERTIFY · THAT · THE · ABOVE · RECORD · OF · WORK · PREFORMED · IS · CORRECT ·

H P Wagner ·FOREMAN·

	1	2	3	4	5	6	7	8	9	10	11	12	·TOTALS·
·AMOUNT·	17.50		26.70	7.—		10.46							61.66
·HOURS·													
·HOURS·													
·HOURS· water boy					10								10
·HOURS· carpenter						8							8
·HOURS· carp. for						8							8
·HOURS· blockmen			14										14
·HOURS· mixers			28										28
·HOURS· concrete for.			7										7
·HOURS· ·TEAMS·	10												10
·HOURS· ·LABORERS·	20	30	9	30									89
·HOURS· ·SKILLED· ·LABORERS·		10	10										20
·HOURS· OVERSEER													
·CLASS·	Y 7/14		Y 11/F	Y 11/F		Y 7/F3							
·WORK · PREFORMED·	Hauling lumber for forms	Form work on north abutment	Pouring south abutment	Excavation north abutment	Carrying water	Form work on floor beams							

Fig. 2. Foreman's Daily Report.

·PARK· Forest		·DATE· Aug 29-1913
·WORK · DONE·	LABOR UNIT COST	·REMARKS·
·SQUARE· ·OF·		machine mixed - 1 3 6 mix
300 ·CUBIC· ft ·OF· concrete	0.089	
·LINEAL· ·OF·		

NOTE :— IF CONCRETE WORK IS REPORTED STATE WHETHER IT IS MACHINE OR HAND MIX. ALSO STATE PROPORTION OF MIX.

·MATERIAL·	ON HAND MORNING	RECEIVED	ON HAND NIGHT	USED	
·SACKS·OF· cement	120	240	310	50	
·CUBIC· ft ·OF· rock	600	350	650	300	
ft sand	100	550	500	150	
·SQUARE· ·OF·					
·LINEAL· ·OF·					
·BUSHELS·OF·					

Fig. 2. Reverse Side of Foreman's Daily Report.

uses those necessary to meet the exigencies of the particular work he is on. The clerk in the office reserves the privilege of making the classifications by letters or symbols (See Construction classification) to best meet the units adopted on the estimating sheet. The reason for this is that the foreman, as a rule, does not have the required amount of education nor the time to go into the details necessary to follow up the symbols or key letters used in the office. The object of "The amount of work done;" "The materials used," etc., is to enable the superintendent to figure, on the job, a quick daily unit cost for the preceding day. For example: I went onto a piece of work the other day on which one of our Engineer Corps was in charge.

PARK DEPARTMENT.
CONSTRUCTION CLASSIFICATION.
Use One Letter and One Number.

A.	Paths.	9.	Carpentering.
B.	Roads.	10.	Watchman.
C.	Steps.	11.	Excavating and Filling.
D.	Lawns.	12.	Concrete Work.
E.	Sidewalks.	13.	Re-Inforced Concrete.
F.	Sewers and Drains.	14.	Granitoid.
G.	Catch Basins.	15.	Miscellaneous.
H.	Curbs.	16.	Cement Finish.
J.	Lakes, Ponds and Pools.	17.	Surveying.
K.	Shrubbery and Trees.	18.	Draughting.
L.	Water System.	19.	Foundation Work.
M.	Equipment and Tools.	20.	Dust or Screenings.
N.	Toilets.	21.	Oil or Covering Materials.
O.	Tennis Courts.	30.	Brick Work.
P.	Baseball Fields.	31.	Painting and Glazing.
R.	Buildings and Structures.	32.	Stucco Work.
S.	Bridle Paths.	33.	Hardware.
T.	Picnic Grounds.	34.	Lathing and Plastering.
U.	Golf Links.	35.	Tile Partitions.
W.	Concrete Seats.	36.	Ornamental Iron Work.
X.	Bubble Fountains.	37.	Sheet Metal.
Y.	Bridge.	38.	Marble and Slate.
1.	Supervision.	39.	Heating and Ventilating.
2.	Lost Time.	40.	Inspection.
3.	Grading and Shaping.	41.	Cinders.
4.	Wrecking and Cutting Down.	42.	Draining.
5.	Hauling Material.	43.	Rip Rap or Telford.
6.	Seeding, Sodding and Planting.	44.	Rolling.
7.	Form Work.	45.	Macadam.
8.	Plumbing and Piping.	46.	Cleaning Up.

Construction Classification.

He reported that he had unloaded a car of rock and that the cost had been $10.00. I immediately told him that that was too much to pay for unloading a car, and that his men had been soldiering on him; he admitted that such might be the case and if so he would remedy it on the next car. When this car came in he was able to report that he had unloaded it for $5.00.

It is impossible in our system to subdivide our general units so that we might have a daily unit cost for form work, handling cinders, placing steel, etc., all of these items being part of one of our estimating units, but the idea is that the superintendent who is supposed, when he sees the daily report, to know the gang's capacity for a day's work, will be able to call the foreman's attention to the fact if he is not delivering the amount of work per capita that he should.

The foreman's daily report is taken to the office and the clerk who, after checking the numbers of hours on the time

·PARK· DEPARTMENT·

·LABOR· COST· DISTRIBUTION· (DAILY)

PARK· Forest ·MONTH·OF· August ·1913.

·DESCRIPTION·OF·WORK· Storm Water Channel Bridge

·LABOR· CLASSIFICATIONS·

·DATE·	·TOTAL· AMOUNT·	Y 1/F	Y 11/F	Y 7/F	Y 12/F	Y 7/FB	Y10	Y4
1								
2								
3								
4	31 50	3 -						
5	40 50	3 -						
6	43 50	3 -						
7	43 50	3 -						
8	43 70	3 -	40 70					
9	47 50	3 -	44 50					
10								
11	49 —	3 -	46 —					
12	45 08	3 -	42 08					
13	13 40	3 -	10 40					
14	50 85	3 -	45 60					
15	56 60	3 -	43 50					
16	51 25	3 -	46 -					
17	1 25							
18	57 65	3 -	47 50					
19	36 23	3 -	23 82					
20	62 60	3 -	43 80					
21	88 42	3 -	51 15					
22	95 55	3 -	46 -					
23	86 55	3 -	48 50					
24	1 25							
25	87 96	3 -	33 40					
26	45 81		- 60					
27	36 86		6 -					
28	66 11		9 -					
29	61 66		7 -					
30	27 27		6 -					
31	- 50							
	1275 05	57 -	648 55					

Fig. 3. Labor Cost Distribution Sheet.

sheet and the distribution of labor, enters the labor distribution on the "Labor Cost Sheet." (Fig. 3). by means of symbols that will get this distribution under the proper units and check back to the estimating sheet. The symbols referred to represent a certain unit of work on a certain job, for instance, finishing on the steps or digging trenches on a sewer system. We have tried to extend our units out to the last item of work done but have found it impracticable on account of the number of symbols required, for instance; we would like to know the cost of form work on the foundation of No. 1 steps on a job on which there are four or five sets of steps, this would mean that it would be necessary for us to use four symbols which would complicate our system and make our office work cost more than it would be worth; so we simply report, form work under the unit upon which the form work was done. However, if the unit cost is high or out of proportion, we can always go into unit detail by referring to the foreman's daily report.

PARK · DEPARTMENT ·

· LABOR · AND MATERIAL · COST · DISTRIBUTION ·

· PARK · Forest · FISCAL · YEAR ENDING · MARCH · 31st 1914.

· DESCRIPTION · OF · WORK · Storm Water Channel Bridge Sewer Dept Account

	· TOTAL AMOUNT	· LABOR · CLASSIFICATIONS ·													
		Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]
· APRIL ·															
MAY ·															
· JUNE ·															
· JULY ·															
AUGUST ·	1275 05	57 00	648 55	187 47	172 27		59 76								
· SEPTEMBER ·	788 31		36 40	12 50		35 10	235 45	214 54	3	15 90	25 70	4 80	90 49		
· OCTOBER ·	317 77						33 70					12 00	102 87	46 00	95 30
· NOVEMBER ·															
· DECEMBER ·															
· JANUARY ·															
· FEBRUARY ·															
· MARCH ·															
· TOTAL LABOR ·	2381 13	57 00	684 95	199 97	172 27	35 10	328 91	214 54	3 00	15 90	25 70	16 80	193 36	46 00	95 30
	· MATERIAL · CLASSIFICATIONS ·														
lumber	196 75			94 42			57 33						40 00		
wire nails	13 40			5 00			5 00						1 70		
steel	639 12							639 12							
gasoline	[illegible] 23				6 00			2 23						28 70	
rock	361 23				178 00			114 00		10 53				53 20	
cement	653 75				300 50			275 45		20 60				6 60	
sand	26[illegible] [illegible]				156 30			88 20		16 80					
TOTAL MATERIAL	2[illegible]5 [illegible]			99 42	640 80		62 33	1140 00		47 93			41 70	88 50	
· TOTAL LABOR	2381 13			199 97	172 27	35 10	328 91	214 54	3 00	15 90	25 70	16 80	193 36	46 00	95 30
GRAND · TOTAL	4526 57	57 00	684 95	299 39	822 13	35 10	391 24	1363 54	3 00	63 83	25 70	16 80	235 06	134 50	95 30
			Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y [illegible]	Y 10	Y [illegible]	Y 4					
SUMMARY ·	4526 57		684 95	178 52	1794 86	2 2 00	481 66	7 30	25 20	147 00					
· QUANTITIES ·			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]								
· UNIT COST ·			$1.5[illegible]	20¢	.3¢	65¢	$1.2								

Fig. 4. Labor and Material Cost Distribution Sheet.

Next we have the monthly labor and material cost distribution sheet. (Fig. 4). Our payrolls and material bills are paid once a month, therefore we find it convenient to balance our accounts from month to month. This sheet is so arranged that we may start work on a park and finish some unit on which we have estimated, and then return several months later and complete the whole. This enables us to have a gang specialize in a particular line of work throughout the season, going from park to park doing their special kind of work, and does not in any way interfere with us in closing our books at the completion of any one unit. On this labor and material sheet material may be bought on one requisition and divided among many units of construction. In this way we can obtain the low price given for large quantities. At the bottom of the sheet you will find the quantities and unit cost of any particular subdivision. I would draw attention to the fact that there are no overhead charges or interest and depreciation charged off the sheet as this is taken care of in our office account and tool and equipment account. The quantities shown are built up on the foreman's report and actual measurements taken on the job after the work has been completed. These quanties are also shown on the estimating and recapitulation sheets for detailed study.

Up to now we have dealt with the book and cost-keeping system as is touched by the engineer. In our work money is appropriated by the General Assembly for certain construction items and under ordinance we must report to the Auditor and Comptroller what this money has been expended for. This necessitates our appropriation register sheet. (Fig. 5). This sheet is one of those prepared by Mr. Peter White and serves its purpose as called for under ordinance in a very thorough manner. It is possibly a little more complicated than the systems in vogue in contracting offices, but it enables us to know just how we stand in reference to the funds appropriated for our use.

In appearance this system may look a little voluminous, but it is kept by one clerk who devotes his entire time to this work and the care of the office. During our busy season there are about 200 men on the payroll which amounts to $12,000 to $14,000 per month. These 200 men have been scattered over as many as 22 different jobs at one time. The one thing that the system lacks is a definite knowledge of what the unit cost is at

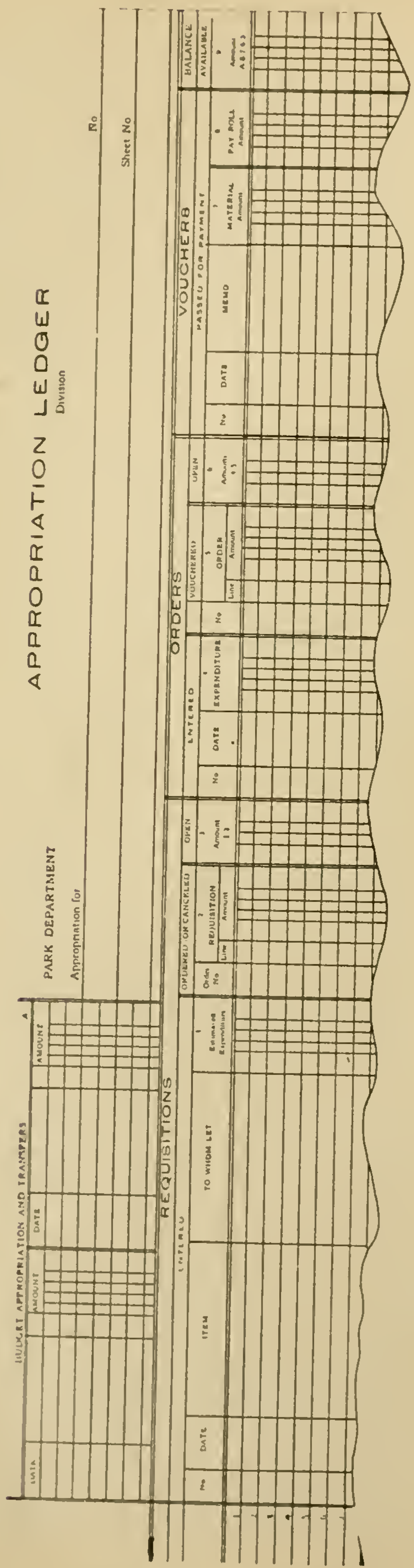


Fig. 5. Appropriation Register Sheet.

any time during the progress of the work except as is shown by the notes on the foreman's report. However, at the completion of a piece of work it does furnish complete data as to the cost of any given unit and from this greater accuracy may be had in preparing estimates for proposed work of a similar nature and conditions.

Probably the most severe criticism that the engineering profession of to-day receives is that they estimate their work too low causing the contractors' bids to be rejected because insufficient funds have been appropriated to meet a proper cost of the work. I feel that if more attention were given to the obtaining and keeping of accurate cost data such as I have described to you to-night, there would be fewer bids rejected on account of being too high. As engineers and contractors we should do what we can to distribute true records of cost on various work that we have been connected with. This theory, I know, is not one adopted by our leading contractors. They are generally reluctant to give out any information regarding unit cost of any work with which they are connected. This I feel is a matter of pride, and must be overcome before the engineer and the contractor will have the confidence they should have in one another.

DISCUSSION.

Mr. F. C. Woermann. Several days ago, Mr. Cunliff kindly sent me a copy of his very interesting paper with an invitation to take part in to-night's discussion. I enjoyed reading the article and congratulate the author on the thorough and satisfactory way in which he has solved many of the difficulties in cost-keeping.

One of the weakest and most unsatisfactory parts of the contractor's, architect's and engineer's work is their methods of cost-keeping and analysis. Each individual has developed a system all his own, and some of these so-called systems are worse than none.

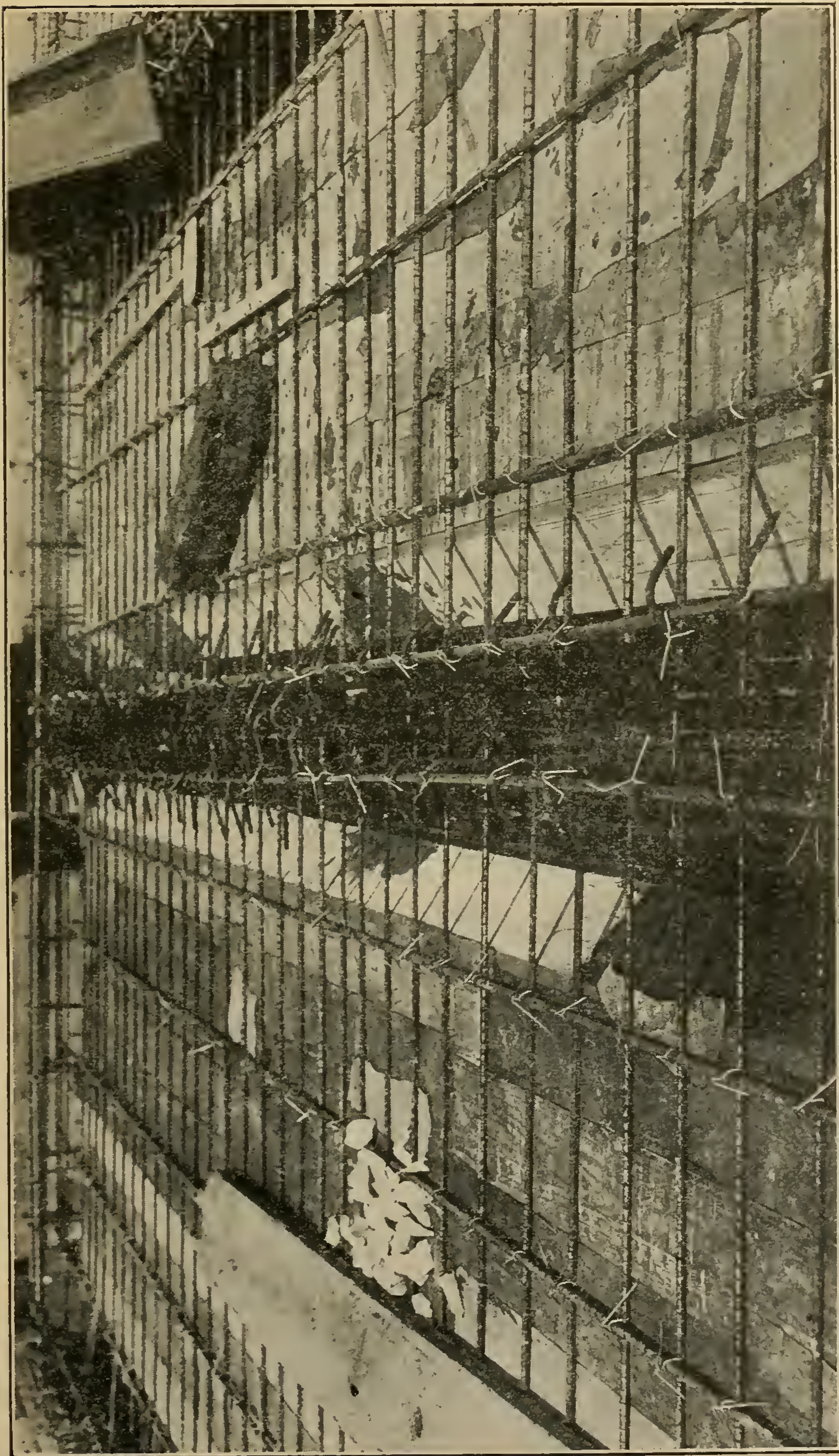
I have been studying and collecting cost data on various kinds of construction work for the past fifteen years, and while I believe I have met with some slight degree of success, yet I must also admit many failures. Some of the early data is almost worthless. I have come to the conclusion that the first and most important step in cost keeping is the division of the

work into cost units, which, in turn, may be subdivided into smaller units.

It is difficult to decide just how far this subdividing should be carried. A subdivided unit system for concrete work which would be ideal for a general contractor may be entirely too crude for a contractor specializing in concrete and entirely too fine for an architect. One of the most successful concrete contractors in New York subdivides the concrete work on a building into forty-five heads and keeps them separate for each floor. I know other contractors who simply need to know approximately the number of cubic yards and the mix, and they can make an estimate. I doubt if any two contractors in St. Louis would follow the same method in making a cost estimate for a concrete building.

For example, in estimating the cost of a reinforced concrete column, all that one contractor needs to know is the tons of steel, the mix and the cubic yards of concrete it contains. The next contractor may wish to separate the bent steel from the straight steel and to know the lineal feet of column forms, the mix and the amount of concrete. The third will insist on knowing the location, the form, size and length of the column, the square feet of form material, the total amount of steel, the amount of steel required to be bent, the mix and the cubic yards of concrete. Each will use different units and different units of cost. All will arrive at practically the same result, but the unit cost cannot be compared.

It is the same in estimating the labor cost for floor forms. One contractor may use square feet of floor area and a certain unit cost. The next may use floor areas plus the additional areas in the beam forms and a slightly lower unit cost. A third may simply use the board measure of lumber in the forms and an entirely different unit cost. Each method has its good and bad points. We, as engineers. contractors and architects have discussed quantity surveying by competent men, who, at the owners' expense, will estimate the amounts of the various kinds of work in a proposed structure and furnish a guaranteed list of same to the contractors. We are looking forward and fondly dreaming of the happy times to come when this is a reality instead of a dream. I believe this will eventually be the rule, rather than the exception, and will result in lower costs and more uniform proposals. However, before this can be satis-



Example of Construction Work in St. Louis Park Department.

factorily accomplished, all contractors, engineers and architects will have to adopt the same unit cost system, and it is up to us to get busy along this line.

I have superintended important construction work for three large and successful construction companies, am familiar with their methods of cost-keeping and have kept copies of practically all of their cost keeping sheets. All are entirely different. Each has a good many points as well as many bad ones, and in devising a cost system for my own use, I have tried to keep the good points from all and eliminate the bad ones, but the deeper one goes into cost-keeping the better one realizes the magitnude of the undertaking.

This becomes still more intricate and stupendous when you are operating in several different parts of the country. The union wage and working rules are generally different in each part, and either one will seriously affect the cost data. For example, in San Antonio, Texas, the carpenters' scale is 37½c; in Albany, N. Y., it is 50c; in St. Louis, 62½c; in New York City it varies from 50c to 70c. In St. Louis and New York City they work 5½ days per week, and in Albany and San Antonio, 6 days. They receive double time for overtime in some cities and time and one-half for overtime in others. In some of the cities the men can make daily reports, but in others, the unions prohibit it. A system that may work well in New York may be worthless in St. Louis. No two cities, nor no two jobs present the some conditions. Cost-keeping is an absolute necessity to the successful contractor of to-day, but good personal judgment and horse sense is also an important and necessary requisite.

Here is one of the problems a contractor operating in various cities is constantly asked to solve: If it costs $10 per thousand to lay brick in cement mortar in the second-story walls of a steel frame building in Albany, New York, where a mason receives 60c per hour, is not allowed to lay down his trowel while handling brick and can only spread mortar for one brick at a time, is served by hod carriers whose wages is 25c per hour and scaffold builders at 40c per hour, with an engineer at the hoist at 60c per hour, what will the same class of work cost in St. Louis laid in lime mortar in the fifth story of a reinforced concrete building when masons receive 70c per hour, but can handle brick with two hands and spread mortar for several

bricks at a time and are served by labor at 40c per hour and engineers at 75c per hour?

Estimating the cost of material is very simple, but each year the labor costs become more complex, and the case just mentioned is a fair sample encountered in cost-keeping and contains about twenty variables.

Our company is using a system of letters and numbers similar to Mr. Cunliff's for the various units and subdivisions and have collected some useful cost data, but we are continually making changes as the weak points develop. Eventually we hope to have a satisfactory system, but we still have much to do before that can be accomplished.

On some jobs I have had special daily report blanks printed for each classification of work, and they were very satisfactory when the jobs were large enough to pay for the services of a first class cost clerk, but the ordinary foreman or timekeeper has not sufficient training to keep a detailed cost account and you are forced of necessity to use only a few large classes of cost units.

On construction of the Bush Terminal Buildings in Brooklyn, New York, we had special time books for each class of work, and the timekeeper divided the time in the field as he checked the men.

On the New York State Power House we had special daily report blanks printed for each class of work and each mechanic made a daily, written report which was Ok'd by the foreman. These reports were then checked with the timekeepers' time and compiled by the job clerk.

On a job we are preparing to construct in New York this summer, we intend using a combination daily time report and cost sheet which will be made by the timekeeper and clerk, but which will show the work for one day only and all compiling will be done in the main office.

The time is entirely too short to go into details to-night, but I would be pleased to have this discussion continued at some future meeting.

Mr. C. L. Hawkins. I have been very much interested in the paper read this evening by Mr. Cunliff, and I believe that he has worked up a system which will show very well the unit costs of the work done by the Park Department.

It seems to me though, that there should be some reports made out at definite intervals which would show approximately the amount of work done, so that if the work is not progressing satisfactorily, or, if the amount of money paid out for labor and materials does not represent the proper proportion of the work done, those facts will be known before the work is completed, and there will still be some possibility of making changes in methods, designs or organization which will keep the total cost of the work within the estimate or the appropriation.

In the case of cost-keeping on street railway track work I understand that the Detroit United Railways Company makes a practice of estimating in detail the cost of all construction or repair work, other than the small emergency repair jobs, and this estimate is sent to the Auditing Department before authority is given to start work. When each job is about one-half finished the cost-keepers and store-keepers make a report to the Engineer of Construction, and their costs are checked against the Auditor's charges. If the work done does not represent the proper proportion of the money spent, steps are taken, if it is thought desirable, to keep the costs within the estimates. This system of checking up the costs before the job is completed, I believe is the proper method, but in the case of track work where so much of the work is covered up by pavements each day, proper precautions should be taken to see that the quality of work done does not suffer on account of the attempts of the men to reduce the costs.

In the track department of the United Railways Company of St. Louis a cost system was started during the year 1908. This system was designed to show the cost of the various parts of the track work, for the purpose of comparing those costs with the costs of the track work let out to contractors and to show the advantages or disadvantages of various methods of construction.

I have here one of our final report forms which any of the members may examine if they care to see it.*

The main fault with this report form was that sufficient space was not provided for showing special conditions affecting the cost of parts of the work, descriptions of methods used, special data on special methods, or for explanations of the increase or

*Impracticable to publish on account of size. Copy can be obtained upon application to the Secretary.

decrease in unit costs from the average. These special conditions and methods are generally known at the time the work is completed, but on account of the rigid report form proper record of them could not be made in this cost report.

I believe that in almost every job where cost data was kept by the track department, the unit costs of some part of the work was decidedly higher or lower than the average unit costs on similar work, but by proper cost reports these unusual costs can be noted, and on future work the costs can be better controlled. By proper cost-keeping we are able to determine definitely just who or what was to blame for unusual costs, and we are then better able to plan and estimate future work.

During the first two or three years of cost-keeping, data was kept on probably six or eight jobs per year, but during the last two or three years, data has been kept on practically all of the large jobs. The final reports were originally made out as called for on this report form, but lately the detailed reports showing the costs better arranged for cost analysis were written on the back or reverse side of the report and the printed form was used for the totals for each part of the work.

The new forms now being prepared allow for a greater variety of methods of handling the work and their use, I believe, will very clearly show the advantages and disadvantages of the various methods of handling each class of work.

To handle the cost-keeping work one inspector is kept with each construction foreman. Where a job is carried on during the night as well as during the day, a second inspector is placed on the night work if necessary.

The number of track laborers on one job may be as many as 200 or more if the job is worked night and day. These inspectors have no connection with the paymaster's department, so they have no work to do except to make out reports showing the time spent on various work and of the amounts of material used.

A clerk in the office checks these reports against the timekeeper's reports and sees that material reports are sent in by the store-keeper whenever charges are made for hauling material. All of these items are entered in a large book ruled for the purpose. Whenever any part of the work is completed, an

estimate of the unit cost of that part is made out. The final report is made out about one week after the job is completed.

The engineer in charge of the cost-keeping department spends most of his time on the work with the various inspectors. He assists in making out material and quantity reports and supervises the making up of the final reports. He also furnishes the Engineering Department with miscellaneous reports in regard to costs and the progress of the work.

The number of men employed on the track cost-keeping system during the past year was about 10.

In the Building Department of the Company no complete cost data system has been adopted, but special cost data is kept on a number of the parts of the larger jobs. Most of the work done by this department consists of general repair work and the alterations of buildings in use, and cost-keeping systems for handling this type of work are usually suitable for only one job.

Mr. W. E. Rolfe. The question of cost records has always been a live one with me, and I have often asked myself the question while working out such a record, "Why is a cost system?" Cost record is kept for the purpose of either showing where our money has gone, or as an aid in preparing us for another similar job. As no two jobs are alike, I think the argument is very clear for rather a free use of the cost system: not to go too much into detail, and not to try to be superlatively accurate. As I look at such a comprehensive cost record sheet as Mr. Cunliff showed this evening, I think how horrible would be the result if he left out an item. The street railway sheet, also contains a large number of items, and I have always found that when I tried to print a sheet, I always had to write in two or three unforseen items that showed up after the work started However, I see Mr. Cunliff has left a few spaces down at the bottom where he can write unexpected headings.

Reference has been made to the fact that the unsatisfactory thing about estimating is that the engineer frequently estimates too low, making it necessary to reject bids. I do not know what the contractor does when he estimates. We let an informal contract two or three days ago for a little job—a contracting job requiring a level head—and our estimate was $1,350. The bids ranged from $749 to $1,860. Now I do not know how the contractors estimated, but the engineer, you will see, hit the

average pretty nicely. I felt sorry for this $749 man and in the goodness of my heart, called him up to see if his feet had chilled, and offered to let him out. He said he had not figured to lose anything and was very well satisfied with his price—and there you are. The point is that the estimating is often handled in an extremely hazy way by the contractor, and, to my mind, the idea is for the engineer to play safe and run high instead of low.

My experience in the St. Louis Water Department has been, almost without exception, to find that the bids came lower than our estimates. I think in City work, as a broad proposition, it may be said that the prices are not high enough for the work as it is done. It would be a good plan for contractors on City work to get together and raise their prices. It would be equitable to everybody concerned. City work is taken at too low prices, in many cases, and contractors sometimes try to put it over on us and recoup on the extras.

I have referred to the difficulty of making printed forms complete. Mr. Woermann referred to the proposition of assembling cost items in the field and using a high grade man in the office to do the final assembling and rounding up of costs. I think this is an excellent idea. My experience has been that men employed as foremen, inspectors, etc.—men who work under the stress of being out on the job—are not in a position to make a very careful or accurate record of what they do and what they observe. If the man on the job gets into the habit of simply, in a running way, writing down his amounts and his observations and a good man in the office translates his "stuff," I think, as a general proposition, you can get better results than to have a man on the job with a card that he writes on in an upright position for part of the time, then sidewise for a while, following with a few notes on the back.

The daily report sheet adopted throughout the Water Department at my suggestion, some five or six years ago, is of the very simplest nature, and I think has proven universally successful in all branches of the work. It consists of a sheet arranged in simple form with a suitable heading for a day's work, then the very broadest general subdivision of that work, leaving some play to the inspector's imagination in assembling his record in his own way. Personally, I have always been better satisfied if the record came in written to the best of the man's

ability, in his own style, and as clearly as he could possibly make it. I think we generally got better results that way than if we tried to go into details in trying to list everything that was likely to go on that job; what we thought of ahead of time, and what we thought we might think of later. The whole proposition is on a par, to my notion, with the overworking of the word "efficiency." We have crowded "efficiency" into everything we have done. We can easily over-systematize and overburden ourselves with cost work. After all, our chief concern in referring to our cost sheets is with the "cost" of the work. As we looked at Mr. Cunliff's blanks, I will venture to say that nine-tenths of us let our eyes wander all over the sheet to find out how much it cost to drive those piles for the pageant stage. We were not particularly interested in knowing that it cost so much per "lick" per cubic foot of displacement. If his record shows us (which it does) that he drove piles for the pageant stage for $1.25 a foot, that is all we want to know, and that will be Mr. Cunliff's chief concern in the future. Extreme care in the presentation of each intermediate step in his process of deduction is not essential.

Mr. A. P. Greensfelder. I am very much interested in the outline Mr. Cunliff has given to-night, and think it is a very valuable help, not only to the man who prepares such a system, but to everyone in the department, in that it enables each one to think clearer.

Regarding the suggestion of Mr. Rolfe of having the contractors raise the price, I think the German scheme is timely in that respect. They take the average of all bids and award it to the bidder who is nearest the average. That is a pretty clever way of picking the right fellow, because the low man usually bids under a severe stress of circumstances. He is either faced with the condition that he has to get work for his organization, or that he is going to gamble out of proportion to the amount of profit.

Engineers should be vitally interested in costs in order that they can make intelligent estimates. An estimate on a several hundred thousand dollar city job was made by the engineer looking up an old inspector who was on similar work twenty years before and asking him what he thought that work should cost to-day. The contractors were asked to come within that esti-

mate, irrespective of conditions or anything else. Now that is an actual fact and happened not a great many years ago.

Referring to Mr. Rolfe's suggestion as to why the man bid so low on that little job he mentioned, it might be interesting to look at that man's next bid on a similar job. It will probably be found that he is the high man. Probably some variation might also be due to the fact that Mr. Low Bidder did not know Mr. Rolfe very well, and the high man had probably worked for him before.

Cost analysis is more vital than cost data, and one of the important functions of cost analysis, from the contractor's standpoint is to enable him to anticipate costs. If he can get his superintendent on the job to get into his mind what a unit should cost, multiply that by the number of units in a particular span, or a hole that he is digging, or material he is unloading, translate the thing into number of men, or hours of labor, he is getting somewhere. For instance, if he knows it ought to cost twenty cents a yard to unload that car, and there are thirty yards in the car, it would cost $6.00. Now, if the wage of a laborer is $2.00 a day of eight hours he should decide right there that it takes three men to unload that car in one day. Thus you do not lose your money and then find out how you lost it, but really anticipate your costs and see that you come within them.

The tendency to go into minute detail is very strong with the man who initiates a cost-system. I have gone through that state more or less myself, and am probably going through it continually. On the first cost cards we got up we had something like forty subdivisions on concrete alone. The very large number was perhaps warranted by the fact that we had a large job, but the minute we left that job we were lost until we lumped some of the general items. But we have been very careful to get the right unit cost. That is one of the most vital things to a man establishing a cost-system, and it is pretty hard for the contractors themselves, much less their superintendents and foremen to get that thought straight. It is only recently that the National Society of Cement Users have aroused themselves to the necessity of arriving at the proper units in concrete work. Up to a few years ago, everyone in town used to estimate concrete by the cubic yard. Concrete by the cubic yard does not

cost the same in any two places. When they began to analyze cost they found that concrete cost so much per cubic foot in place; the cost of forms was so much per square foot and the reinforcing steel cost so much per lineal foot. When they started to analyze those things they got to the point where they really started to see clearly.

We have eliminated daily cards—we have gotten down to the weekly sheets, but we have tried to train our superintendents to anticipate costs. We find that concentration along that line has been quite effective.

In Mr. Cunliff's estimate sheet he shows "deficiency." As clearly as we might think regarding deficiency it is impossible to show it accurately in figures. For instance, he gives equal value to his estimate on material; to his estimate on sub-bids, and his estimate on labor which he performs, or as the contractor must perform it. Now, they have three different values. Sub-bids are practically constant, so you might neglect them as far as giving them weight is concerned. Material quantities are only slightly variable. For instance, so much gravel goes into a yard of concrete and you cannot put in any more or any less. The labor item, however, is the large variable, and for that you must allow proper weight.

Another thing I did not notice there was, liability insurance. The City may not carry liability insurance, but of course a contractor has to carry that or take the chances of being put out of business through an accident beyond his control. Liability insurance is based on the pay-roll. Again, the pay-roll is subject to three things beyond a contractor's control, and that is where judgment comes in. Those three things are: weather conditions; underground conditions—that is, he has not jurisdiction over nature—he don't know what is in the ground, and he does not know what is going to happen there; and the third is material deliveries, which affect his labor costs. For instance, if you have ordered a car load of steel and the mill delays shipment you may delay the job, but your cost goes on the same, because you will hold your superintendent, foreman, etc., anticipating the arrival of that car. You are absolutely at the mercy of the material men supplying fabricated material. You can tie up a man with all the red tape you please, but if that man has half of your window frames made and has not the

other half, you cannot take the contract away from him, because by the time you give it to some other mill and get started, he would come along. So in fabricated material we have gotten beyond that point where we let it to the lowest bidder. We let it to the man who can give us service. The value of service is rapidly becoming realized by everyone. They realize that the low bid is not necessarily the cheap one. Particularly is that true in large undertakings, where the interest on the money in the job, because of the delay, is large. Take an office building for example: As the work progresses there is $100,000 invested and rentals are dependent upon that building being finished by a certain day. Only recently a seven-story building was let to be finished in ten months. It was awarded at a very low sum. The building was not finished in ten months; the owner has lost half of his tenants, and you can image his financial difficulties. He is going to put up another building soon and he is not going to let it to the lowest bidder, but to the man who can give him service.

The scheme of a visible cost diagram is a very good one and is coming into more universal use. By its means a man can look at the progress profile and note the rate of progress and quantity at a glance. The tendency has been, however, to show the whole job on one sheet, which shows the various items, both as to quantity—which means speed—and as to cost.

Mr. Cunliff has on his sheet an item of lost time. I do not know what he means by that, but if he realized that all his time chargeable to his department must be divided among the jobs, why he has realized a thing which most engineers in charge of work—their own construction work—do not realize. They will try to bring the cost on a particular job down, forgetting that the sum of those costs at the end of the year will not equal their pay roll, and that is a thing that the contractor must do, because his money is spent, whether it has gone on one job or another. On jobs done by company forces or municipal forces, you will often find that they say that their costs are very low—they can beat a contractor on their costs. If they will take the trouble to add up the cost of their jobs they will find there is a big difference in the cost of those jobs and the actual money spent by the department. Do not try to fool yourself, even if you must fool your boss.

There is another item I have not heard mentioned to-night, and that is, plant. Plant, of course, is absolutely essential, and in a large job it is one of the most vital things to consider, and a contractor in bidding on a job ought at least to convince himself of one way of doing that job. He may change that method of doing it many times before he finishes it, but in bidding he should have in mind one definite way of doing the job, and in planning the cost should estimate the plant necessary and depreciation in equipment.

One of the things so common among engineers, contractors and architects, or whoever is in charge of work, or anything else, is to hide the failures, and I think if engineers, contractors, or architects are to be censured for any one thing, it is because they do not mention their failures. As a member of this Club for ten years, I have yet to listen to a man who will tell us of some of his failures in design or construction, and those are just as vital as his successes to his fellow engineers who have been through the mill and know that every time we strike at a nail we do not hit it on the head.

Then we come to the last thing in estimating a job, and that is, who is the engineer in charge? How is he going to interpret his specification, and has he had any experience in this class of construction work? If you must work under an inexperienced engineer—a man who does not know how to do work—your troubles just begin, and your costs fly to the winds. He may require you to do things that fifteen years later he would not think of asking you to do, simply because he has not had the experience to know the value, or given proper weight to things he is asking you to do. The personal equation of the engineer in charge is one of the most interesting and vital things to the contractor. It almost means profit or loss. It almost means success in the job and failure to the contractor. The broad engineer who succeeds is the man who tries to place himself on both sides of the fence, and does not think that maybe if the contractor is making a few dollars he is also injurying the work. Deep down in the hearts of both men is pride in the work they are doing. A man is not in business only for the dollars in it. He is in it because he likes the work and because he takes pride in it. This applies not only to the contractor, but the superintendent and the foreman and the man who is driving a nail or shoveling dirt. Each individual has a certain amount of pride,

so do not crush that pride. Recognize it and he will help you do the best jobs turned out.

Mr. Dwight F. Davis. I came here to-night to listen and learn, and not to talk, and I expected to go home feeling that I knew all about cost data and cost analysis, but, unfortunately, after hearing the first discussion by Mr. Woermann I am going home more mystified than before, owing to the many items that enter into the question.

I think Mr. Greensfelder has hit the nail on the head in saying that the important thing is cost analysis—to know really what we are doing and why we are doing it. It is a very fascinating thing to work out a cost data system, and, I think, as Mr. Greensfelder said, that when we once start on it we are very likely to over-reach ourselves and get the system down too fine.

I do not agree with Mr. Rolfe that you should leave out details, for several reasons, one of which Mr. Cunliff illustrated in the cost of unloading the rock. In that case the day after the foreman had taken too much time for that job, as shown by the cost system, he corrected the waste. It is worth while to get down to the details if you can actually make a saving at the time and not wait to find out afterward where your money has gone.

I think there is another factor in this matter that is not usually recognized, and that is what you might call the moral factor—the moral influence. I have noticed it in the Park Department particularly. I think the Park Department, two or three years ago, was decidedly a horrible example in this matter of cost data. We had absolutely no idea where the money was going. At the time I came into the Department, I found we got our appropriations, for example, in practically two items for each park—labor and material. Take for example Forest Park. We would get a lump sum of seventy odd thousand dollars to run Forest Park, divided into material and labor accounts. That would include the Zoo, the green houses, work on the roads, cutting of the grass, bridges, and all that sort of thing, but we did not have the slightest idea what it was costing us to do any of the work. We knew it was costing us so much a month to take care of Forest Park, but we did not know whether we were spending that money on the Zoo, on the roads, or spending it on the green houses, or in other words, we did not know what we were spending our money for. Worse than that, on materials, I found they had absolutely no record, after

the beginning of the year, of the orders outstanding. We have rather a complicated red tape system of putting in requisitions, which go to the Supply Commissioner. After a certain amount of red tape is unraveled, he buys the goods, and after a month or two rolls around, we finally get the bills and the vouchers are made out. Now, they had absolutely no record after the beginning of the year, of requisitions outstanding. They know when the orders came back and the vouchers were sent that so much money was spent, but they did not know from the beginning of the year what balance they had on hand. As I say, I think that was a horrible example. This has been worked out, starting with Mr. Peter White's system, which we developed by the addition of other items that came up.

As I started to say, we found one feature—the moral feature—is really an important factor in all this matter; that where the men think that you do not know what is going on, they are likely to do their work in a slovenly way, but when a foreman realizes that Mr. Cunliff knows the next day what it costs to do a certain piece of work, he is going to do that work better, not only because he wants to hold his job, but because he wants to get his job down to the most efficient basis, and it does have an effect on the man. It has an effect on the men in the office and it has got some of our men, where we have a more ignorant class, feeling that, through the daily records, we have a sort of eye on them—a detective who is tracing them up. They do not realize that the figures turned in to us are always checked up—they do not look at it from that standpoint, but they are trying to do their job in the most efficient way, and I think that is the most important feature in the work, and when they realize what we are trying to get at, they do take a greater pride in the work and they try to do it in a better way and a cheaper way. We had another way of encouraging that. Last summer on the Fair Ground Pool, where the foreman knew he could lay a certain amount of squares in the bottom of the pool in a day, we found we could encourage the speed of the work, and a saving in the cost, by making a little bet with the foreman of a box of cigars that he could not lay more than a certain number of squares a day, and he tried to lay a couple of extra squares to earn that box of cigars. I do feel that it has an influence beyond mere figures—an influence on the men themselves, and I noticed that

particularly in our Department, which has come from being a horrible example to, I think, a fair example of efficient work.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

SAFETY IN ELECTRICAL WIRING.

By F. C. Green,*
Member of the Oregon Society of Engineers.

When the Secretary called over the telephone the other day and informed me that the Programme Committee desired that I be one of several to give a talk of not to exceed five minutes, I was very much surprised. I cannot be said to have been a very good member of the Oregon Society of Engineers having attended but one meeting in two years, so I am a stranger to you, in fact I am not acquainted with our mutual enemy, the Programme Committee, who have inflicted me upon you.

To introduce myself, however, I am and have been for the past two years in the electrical contracting business. While I previously had been engaged in another branch of the electrical business, contracting was entirely new to me. I found, however, plenty of problems, and it is towards the solution of one of these that I want to direct your attention.

It would be instructive, interesting, and I dare say, amusing if I could get the mental pictures that come to the minds of the men assembled here when the words, "Electrical Contractor," are mentioned. A young friend of mine now taking an electrical course expressed an altogether too common and too true an idea when he said: "If I intended to take up electrical contracting I wouldn't be going to school." In other words, the problem I desire to bring to your attention is the incompetency of the men engaged in a business that constitutes a fire and life risk.

I have been informed that from 7 to 15 per cent of our fires are electrical in origin and that our per capita loss from all fires is from $2.40 to $2.60 per annum, exclusive of the cost of fire departments. Using average figures the annual loss due to defective wiring in Oregon is therefore approximately $190,000. This loss is one that can be and should be remedied. The most notable and the most likely to be remembered in Portland was the destruction of the Union Oil Co.'s plant at which time Fire Chief Campbell lost his life, just three years ago to-morrow. This, I understand, was electrical in origin.

The question, of course, will naturally be asked, Why do not responsible, reliable electrical men get busy and eliminate the incompetents? This is just what we have been trying to do.

*Secretary Oregon Electrical Contractors' Association.

Through combined efforts of the electrical interests, we now have an electrical ordinance and inspection department which is in the main good. There is, however, no test of fitness, the only requirement being the ability to get $5.00 with which to secure a bond. The problem, however, is not a local one and should be handled by the State and an examining board created with power to issue and also to revoke licenses whenever inferior and hazardous work is shown.

The Oregon Electrical Contractors' Association has prepared such a bill, but time does not permit a detailed discussion of the same. The following facts, however, should be kept in mind when considering this subject: This bill will not prevent a man from wiring his own house, and manufacturing concerns or any corporation can have their engineers do their wiring, providing first that he takes the examination and becomes a qualified "Master Electrician." This bill will not keep any one out of the electrical business who is competent to be in the business. This bill will protect the property owner from incompetent and unscrupulous contractors by providing a bond whereby the owner can recover in case work is not properly performed. This bill will not be a burden to the taxpayers, as it is entirely self-supporting. In other words, we are not attempting to create an electrical trust and unless we can convince others than ourselves, who naturally have a selfish interest in this matter, we shall deservedly fail. I trust, therefore, gentlemen, that when the time comes, the Oregon Electrical Contractors' Association can receive a hearing and also receive your collective, as well as individual endorsement to this measure.

[NOTE—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

THE NEW CITY CHARTER OF ST. LOUIS.

[Vol. 53, page 26.]

(From *Public Affairs,* the official publication of the Civic League.)

The adoption of a New City Charter on June 30th by a vote of 46,834 to 44,158 will revolutionize practically every department of city government. It means a new day for St. Louis in the extension of public improvements, the efficiency of public work and the active participation of citizens in city government. It means the breaking up of the power of the spoilsman and the franchise holding interests in city government.

The New Charter is one of the most democratic instruments of government ever written for an American city. Its theme is power. It gives power to the city to own and operate any utilities or business; to the citizens power to control legislation through the Initiative and Referendum and their elected officers through the Recall, and to public officials to serve the people.

The Charter is a short, clear, elastic instrument. Its important features are:

(1) Unlimited power of municipal ownership, (2) Initiative, Referendum and Recall, (3) the single legislative body elected at large, (4) the appointment of all employes on a basis of merit (5) the simplification of all departments and the concentration of power under three separate heads: the Mayor; the Board of Public Service; and the Board of Estimate and Apportionment. The Mayor is the general city manager: the Board of Public Service has charge of all public improvements, and the Board of Estimate and Apportionment holds the purse-strings.

The Charter was won only after a long, hard fight. It was a victory for the progressive forces of the city. The Charter movement has been actively under way since 1909, when the first Board of Freeholders was elected. The Charter drafted by them was defeated on January 31, 1911, by a vote of 65,324 to 24,817 (total, 90,141). Since that time the science of municipal government has made such rapid strides that the new Board of Freeholders wrote an entirely different kind of Charter.

The readjustment will bring many new problems, in which civic organizations and citizens must play a large part if they are to be satisfactorily worked out.

Copies of the New Charter can be obtained upon application to the City Register, City Hall.

[NOTE—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

ASSOCIATION

OF

ENGINEERING SOCIETIES

Vol. 53. AUGUST, 1914. No. 2.

PROCEEDINGS.

The Oregon Society of Engineers.

Regular monthly meeting of the Oregon Society of Engineers in Room "A," Public Library Building, June 25, 1914, at 8:00 p. m.

The meeting was called to order by President Graves who presided.

The minutes of the meetings of April 9 and May 4 were read, and approved.

Mr. Fred A. Ballin spoke on "The Probable Effect of the Panama Canal Upon Shipping Along the Pacific Coast," expressing the belief that the effects of the Canal would not be felt in Portland for some time to come, if at all.

Mr. F. C. Green's subject was "The Work of the Electrical Contractor." He called attention to the fact that a great number of incompetent men were engaged in electrical work, and that the annual fire loss due to faulty wiring is enormous.

Mr. Chas. McGonigle read an excellent paper on "The Manufacture of Structural Steel and Iron."

Mr. C. L. Reed told of the work of the engineer in modern development, calling attention to the gas engine, large steam engines, the cyanide process and electricity. He spoke of the "Titanic" as a great engineering work, combining in itself a great number of products of the engineer's brain, all brought to a high state of perfection.

Mr. Henry S. Morse suggested that a meeting devoted to a discussion of the question, "Is Engineering a Business or a Profession?" would be profitable and interesting.

Mr. O. E. Stanley called attention to several points that had come to his attention as secretary.

Mr. Goldberg moved that the executive board be instructed to have Mr. Stanley's remarks printed and sent to each member of the society, providing that the expense is not too great.

Mr. Graves called attention to the fact that an engineer from a distance could get more work in Portland than one who had made his

home here for some time, and suggested that we find the reason, and if possible, remedy it.

Upon motion by Mr. Crawford the chair was authorized to appoint a committee to investigate the "Made in Oregon" movement.

It was suggested by Mr. Ballin that the subjects for papers in the future should rotate among the different branches of engineering represented in the society.

This idea was emphasized by Mr. Reed, who also offered the criticism that some of the papers in the past had been too general, and urged that they be more specific in the future.

Mr. C. S. Goldberg gave it as his opinion that engineers themselves are not to blame for their present condition, but that economic conditions should be changed, particularly as to the ownership of land.

Upon motion, the society adjourned until September.

ORRIN E. STANLEY, *Secretary.*

The Engineers' Club of St. Louis.

The 773rd meeting of the Club was held in the Club Rooms, Wednesday, May 20, 1914, at 8:15 p. m., as a party meeting with the St. Louis Branch of the A. S. M. E. President Greensfelder called the meeting to order and, after disposing of business before the meeting, called upon Mr. F. E. Bausch, Chairman of the A. S. M. E., to preside. There were present 37 members and 28 visitors.

The minutes of the 771st and 772nd meetings of the Club were read and approved.

Messrs. F. G. Jonah and J. D. von Maur reported on their trip to Memphis as representatives of the Club at a meeting of engineers in the City of Memphis for the purpose of organizing a local society.

Mr. W. S. Mitchell, Chairman of the Public Affairs Committee, reported on the work of the Committee in reference to the New City Charter and recommended that the Club take action. Motion carried that a referendum ballot containing the three following propositions be submitted to the Associated Engineering Societies of St. Louis: Whether members approve or disapprove the New City Charter; whether the Association, as such, shall indorse the New City Charter; whether the Association, as such, shall actively co-operate with the Joint Charter Conference in their endeavor to gain publicity and indorsement for the New City Charter.

The presiding officer then presented Captain Robert W. Hunt, of the well known Bureau of Inspection and Tests, who read an illustrated paper on Steel Rails, their manufacture, inspection and service. The illustrations showed the principal steps in the process of manufacture of steel rails from taking the raw material from the ore pits to the final tests and delivery.

Adjourned 11:15 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

The 774th meeting of the Club was held in the Club Rooms, Wednesday, May 27, 1914, at 8:15 p. m., as a party meeting with the A. S. C. E. Members of the Municipal Contractors' Association of St. Louis were guests of the evening. Mr. Edward E. Wall, Vice-President of the A. S. C. E., presided. There were present 36 members and 7 visitors.

The presiding officer presented Mr. J. C. Travilla, Consulting Engineer, formerly Street Commissioner of the City of St. Louis, and one of our leading authorities on Roads and Pavements, who presented an illustrated paper on Tarrant County (Texas) Roads.

About ten members and guests participated in the discussion which followed.

Adjourned 10:30 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

The 775th meeting of the Club was held in the Club Rooms, Wednesday, June 3, 1914, at 8:15 p. m., as a joint meeting of the Associated Engineering Societies of St. Louis under the auspices of the St. Louis Branch of the A. S. M. E. President Greensfelder called the meeting to order. The total attendance was 68.

The Assistant Secretary announced the results of a canvass of the referendum ballot submitted to members of the Associated Engineering Societies of St. Louis in accordance with a motion carried at the 773rd meeting of the Club, as follows:

Total number of ballots cast..........................91
Proposition A—Yea............76; Nay............13
Proposition B—Yea............74; Nay............16
Proposition C—Yea............72; Nay............16

Professor E. L. Ohle, Secretary of the St. Louis Branch of the A. S. M. E., thereupon took the chair and presented Mr. H. R. Setz, Chief Engineer of the Oil Engine Department, Fulton Iron Works, who delivered an interesting talk on Diesel Oil Engines. Discussion followed.

Adjourned 10:30 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

Editors reprinting articles from this JOURNAL are requested to credit the author, the JOURNAL OF THE ASSOCIATION, and the Society before which such articles were read.

ASSOCIATION ENGINEERING SOCIETIES

ORGANIZED 1881.

Vol. 53. SEPTEMBER, 1914. No. 3

This Association is not responsible for the subject-matter contributed by any Society or for the statements or opinions of members of the Societies.

REGULATIONS OF THE ASSOCIATED ENGINEERING SOCIETIES OF ST. LOUIS.

Composed of the Engineers' Club of St. Louis, With Which Are Affiliated the St. Louis Association—American Society of Civil Engineers; St. Louis Section—American Society of Mechanical Engineers; St. Louis Section—American Institute of Electrical Engineers; St. Louis Branch—American Society of Engineering Contractors.

LAST AMENDED BY THE JOINT COUNCIL, APRIL 4, 1914.

(Editorial Note: These regulations are the outgrowth of a "get-together" movement, which was started among the engineering societies of St. Louis about three years ago. The joint meetings have been eminently satisfactory to all concerned. The attendance has been practically doubled. Papers and discussions have increased in number and value. Many new acquaintanceships have been formed and there has been a notable increase in good fellowship. In the application of the original regulations it was found desirable to make certain modifications and amplifications, and early in the present year it was decided to incorporate these in the official form and also provide for a more equitable division of the expenses of the association.

The following regulations were prepared by the joint council after an extended discussion and have been adopted by all of the societies. As inquiries continue to come in from other cities and the stock of printed copies has been exhausted, it was decided to publish them in the Journal for permanent reference and for the benefit of the engineering fraternity at large.)

ARTICLE I.

Name.

Section 1. The name of this association shall be the "Associated Engineering Societies of St. Louis" and its object shall be the unification and co-operation of the engineering societies of St. Louis.

Sec. 2. With the Engineers' Club of St. Louis the local organizations of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Society of Engineering Contractors are charter affiliated societies of this association. Local organization of fifty or more members which are branches of other national engineering bodies are eligible for affiliation.

ARTICLE II.

Council.

Section 1. The affairs of the association shall be conducted by a joint council consisting of the president and two junior past-presidents of the Engineers' Club, together with two other councilors chosen by each of the affiliated societies, one each year for a term of two years, at least one of whom shall be a member of its governing committee, and at least one a member of the Engineers' Club.

Sec. 2. The president, treasurer and secretary of the Engineers' Club shall act in similar capacities for the council. In the absence of its president, the council shall choose a chairman. The treasurer shall collect all dues. The secretary shall mail notices at least two days in advance of all meetings, and record the minutes thereof.

Sec. 3. Meeting of the council shall be held upon call of any two councilors, but not less than quarterly upon call of the president-

dent. Five members, representing at least four societies, shall constitute a quorum. The yea and nay vote of members on all questions shall be recorded. Decision of the council shall require at least five votes representing at least three societies.

SEC. 4. The council shall have jurisdiction over all matters of joint interest in so far as their decisions shall not conflict with the rules of the various societies. Upon petitions for affiliation of other societies and special financial matters, the recommendations of the council shall be printed in the notice for the next joint meeting of the association, when a three-fifths vote shall be necessary to decide the question.

SEC. 5. The societies in the association shall act jointly on all local public affairs presented for consideration to any one or more of the societies. Such questions shall be referred to the council for their recommendation, which shall be printed in the notice for the next joint meeting. Such meeting shall by majority vote decide the advisability and form of a referendum ballot returnable in ten days, when the yea and nay ballots shall be counted, and if signed shall be so recorded by the secretary. If such meeting shall decide against a referendum, a two-thirds yea and nay vote shall be necessary to decide the question. The result in either case, if made public or published, shall reçite the date, the number of votes for, against and not voting or attending.

SEC. 6. In national public affairs, the recommendations of the council, if any, shall be printed in the notice for the next joint meeting when a three-fifths yea and nay vote may decide to refer the question to the consideration of one or more national engineering bodies through their affiliated societies.

ARTICLE III.

MEETINGS.

SECTION 1. Each society shall arrange two technical "joint meetings" per calendar year in which all other societies shall participate. One joint banquet annually shall be, and other joint meetings may be arranged by the council. Resident members in good standing on the lists of the secretaries of the societies participating in joint meetings shall be known as "joint members,"

and as such shall be entitled to all the benefits of such meetings and shall share equally in their cost.

SEC. 2. Each affiliated society shall arrange all its technical meetings other than joint meetings as "party meetings." In party meetings, only the affiliated society and the Engineers' Club shall participate. Resident members in good standing on the lists of the secretaries of the societies participating in party meetings shall be known as "party members," and as such shall be entitled to all the benefits of such meetings and shall share equally in their cost.

SEC. 3. Each individual affiliated society may arrange non-technical "individual meetings" in which it alone may participate.

SEC. 4. The auditorium of the Engineers' Club shall be available for all joint and party meetings. At joint meetings the order of business shall be as follows: Call to order by president of council; reading of council minutes; joint business; call to chair of presiding officer of conducting society; new business of the society; presentation of technical subject; joint discussion; adjournment. The technical subjects at joint meetings shall exclude matters of meager interest, of careless preparation or of pure advertisement of commercial articles. At party meetings the presiding officer of the conducting society shall officiate, and may conduct its regular order of business, but members of the Engineers' Club shall have the privilege of participating in the discussion of the technical subject. At joint and party meetings, members of the participating societies may invite visitors who shall be permitted to discuss the technical subject.

SEC. 5. The Engineers' Club, having an auditorium, library, club rooms, employment bureau, weekly technical papers on local matters, entertainments, local monthly bulletin for news items, national monthly journal for the publication of papers, and the service of a paid secretary, for the engineers in the community who have united for their mutual welfare and who will further contribute for professional and social purposes, is recognized as the parent engineering society of St. Louis. The Engineers' Club therefore reserves the right to hold technical and social meetings and excursions with or without participation of one or more affiliated societies.

ARTICLE IV.

Dues.

Section 1. General disbursements of the Engineers' Club shall include for the year 1914, the five following items: (1) Assistant secretary *printing service* at four dollars per meeting notice, and *programme service* at ten dollars per meeting; (2) *printing and postage* at two cents for each meeting notice to joint and party members; (3) *rental of auditorium* at ten dollars per meeting; (4) *publication of joint year book* at forty cents per joint member; (5) *furniture renewals.* The council, in January, for each current year shall equitably proportion all general expenses among the societies according to their pro rata joint and party members. Special expenditures of the Club shall include stenographic service, lantern slides, refreshments and individual service. The treasurer of the council shall submit quarterly to each society itemized bills for its pro rata share of such general and special expense based on the total number of joint and party meetings during the past quarter.

Sec. 2. The Club shall pay quarterly its pro rata share for its joint and party members who are not members in any affiliated society. Each affiliated society shall pay quarterly its pro rata share for all its joint and party members. Joint and party members of the Club who are also members of one or more affiliated societies shall have their annual Club assessment reduced such pro rata share for each such membership. If any affiliated society decides that its members who are also members of the Club prefer not to avail themselves of such reduced Club assessment, any such amount paid to the treasurer of the Club will be credited by him to that affiliated society.

Sec. 3. The Engineers' Club shall charge each affiliated society fifteen dollars for *rental of auditorium* for each individual meeting held therein which charge shall include cost of the individual notices.

Sec. 4. The Engineers' Club may for a time waive its initiation fee to new members of an affiliated society who join the Club within three years after joining such society, and during that time shall credit his initiation fee to any new member of the Club who joins an affiliated society within three years after joining the Club.

SEC. 5. The Engineers' Club shall set aside all initiation fees as a "furniture renewal fund," for reconstructing, refurnishing or moving joint quarters. It is recognized that affiliation with the Engineers' Club will be a strong factor in increasing the membership of each affiliated society. Therefore until the Club shall waive its initiation fee, or make it the same for *all* new members, each affiliated society, in order not to be recipients of special privilege, shall pay a share into such fund. Such sum or "*Quarters' fee,*" shall be the Club initiation (at a rate not less than two dollars per year each) for such members of the Club joining that affiliated society within their three year limit. This fee shall not exceed twenty-five dollars in any one year for any affiliated society.

SEC. 6. In furtherance of the spirit of the Engineers' Club which prompts it to offer its reception rooms free in order to promote local united engineering activities, each affiliated society shall encourage its members to join the Club in order that they may gain social relationship with, local professional standing among, and personal friendship of, fellow engineers in St. Louis. The Engineers' Club shall encourage its members to join a national engineering body through an affiliated society.

ARTICLE V.

SERVICES.

SECTION 1. The Engineers' Club shall print and post a joint year book, and all notices of joint and party meetings and individual meetings held at the Club. Individual notices shall be sent only to members of the issuing society, party notices to party members, joint notices to joint members and the year book to members of all societies. The year book, in sections, shall contain lists of officers and committees, rosters, condensed reports of officers, programmes, rules of each society and its associations, statistics and such other matter as the council shall decide, provided the Club shall be furnished the necessary data by February 1st.

SEC. 2. Papers and available discussions presented at joint or party meetings shall have consideration for publishing in the national Journal of the Association of Engineering Societies. Available discussions of papers at joint or party meetings by

members of the Engineers' Club may be printed with such papers if published by an affiliated society. Stenographic services, lantern slides or special apparatus desired at any meeting may be furnished by the Engineers' Club, but shall be paid for by the society requesting the same.

Sec. 3. Refreshments served at any joint or party meeting may be furnished by the Engineers's Club, but shall be paid for by the society requesting same.

Sec. 4. The attendance of the paid secretary of the Engineers' Club shall be available gratis for joint or party meetings, but the preparation of individual minutes or his special services at other times shall be paid for by the society requesting the same.

ARTICLE VI.

Revisions.

Section 1. An affiliated society failing in its obligations shall be notified in writing by the council, and if such obligations are not met within three months thereafter, such society may be dropped from this association, upon vote of a majority of the council in letter ballot. Any society may withdraw from the association three months after service of written notice to the council, provided it is not financially in arrears.

Sec. 2. These regulations may be amended or suspended by the council by submission in writing and majority vote at any meeting thereof, and then approved by a three-fifths yea and nay vote at a joint meeting, the question having been stated in notice of that meeting.

Sec. 3. These regulations shall become effective July 1, 1914, if adopted by the Engineers' Club and by at least two of the affiliated societies. They shall be revised as a whole at least every five years by the council for approval by a three-fifths yea and nay vote at a joint meeting, the revised regulations being printed in notice of that meeting.

"PRESENT WORTH" CALCULATIONS IN ENGINEERING STUDIES

By Walter O. Pennell,*
Member of the Engineers' Club of St, Louis.

[Read before the Club, April 22, 1914.]

Most of us remember "Present Worth," if we remember it at all, as a subject we used to study in our school days in arithmetic, together with such other interesting lessons as Interest, Discount, etc. Comparatively few, I think, know that there is a wide application of the principle of "Present Worth" in many broad engineering studies. It is to point out and explain some of these applications that I ask your attention for a short while to-night.

"Present Worth" is defined in Wentworth's Arithmetic as follows:

"The *present worth* of a sum of money due at the end of a given time, is the sum that put at interest for the given time will amount to the given sum."

To nearly every engineering problem there are generally several solutions. Sometimes the advantages of one course are so apparent that no further study is necessary. Often, however, it is difficult to say without careful analysis, which is the best plan to follow. Sometimes questions of finance, or policy influence the result, and that course may be chosen which does not result in the lowest annual charges, but which means the least first cost, or can be the most easily financed. Generally the several alternative courses involve different expenditures and charges extending over a period of years. In order to compare these charges intelligently it is necessary to reduce them all to a common basis. An example may make this clear:

Certain machinery cost $100,000 and is now only three years old. Improved machinery is on the market, which will cost $125,000 but which will effect an annual saving of $18,000. In any event, e. g., whether the new machinery is installed or not, the plant will be abandoned at the end of eight years. There will be a salvage value of 10 per cent on the machinery removed. Which is the cheapest course to follow?

Let us assume that the problem is correctly stated above. (I might here remark that in engineering questions as well as many others in this life, often half the work is done when the problem is stated clearly and concisely, with all reasonable alternatives

*Equipment and Building Engineer, Southwestern Bell Telephone System.

outlined.) Now, in our specific problem, it is not apparent which is the cheaper course unless we compare the "Present Worth" of the annual charges—somewhat as follows:

Plan 1—Install new machinery:

Nature of work.	Cost.	Period.	Annual Charges. %	Amount.	Factor.	Present Worth.
New Machinery..	$125,000	1-1-15 to 1-1-23	24.0	$30,000	6.22	$186,600
Transfer Loss on Removing Old	59,499	1-1-15	......	....	1	59,499
						$246,099

Plan 2—Retain Old Machinery:

Nature of work.	Cost.	Period.	Annual Charges. %	Amount.	Factor.	Present Worth.
Old Machinery....	$100,000	1-1-15 to 1-1-23	20.9	$20,900	6.22	$129,998
Excess Cost of Operation	18,000	1-1-15 to 1-1-23	......	....	6.22	111,960
						$241,958

The annual charge for each course is made up as follows:

Analysis of Annual Charge:

	Plan 1	Plan 2
Interest	6.0%	6%
Depreciation, 8 yrs. life 10% salvage	9.1%	
Depreciation, 11 yrs. life 10% salvage		6.0
Taxes	1.5	1.5
Insurance	.5	.5
Administration	.5	.5
Maintenance	6.4	6.4
	24.0	20.9

The depreciation is calculated for Plan 1 as follows:

An annuity of $10.1 for 8 years at 6 per cent will amount to $100. Since the salvage is 10 per cent, the value subject to depreciation is 90 per cent. 90 per cent of 10.1 is 9.1.

In a similar manner the depreciation for Plan 2 is calculated. The transfer loss, Plan 1, is the amount of the depreciation on $100,000 at 6 per cent for 8 years.

These values are obtained from the table as explained later on.

In this case, if there are no other factors involved, it is about $4,000 cheaper to retain the old machinery. This is, of course, a very simple illustration. Many of the problems are much more complex.

It is important to have the calculations tabulated concisely, and for this purpose the form above is well adapted. The first column gives a description of the nature of the work or charge; the second, the cost of each item; the third, the time period of the charges; the fourth and fifth, the per cent and amount of annual charges which I will refer to in detail later on; next, a column showing the factor, which, when multiplied into the charges, will give the present worth.

Following is a table of interest and present worths which I have found convenient and adapted to nearly every problem requiring present worth calculations. In an appendix will be found similar tables calculated for 3, 4 and 5 per cent interest, respectively.

I have found the use of these tables the most convenient method of making present worth calculations. I have drawn, however, several curves, which will show the same information as the tables. They are useful as a quick method of interpolation for fractions of a year and some may prefer to use the curves in place of the table.

Table 1.

TABLE OF PRESENT WORTHS.

Figured at 6 per cent interest compounded annually.

Col. 1 Years	Col. 2 Amount at end of each year of \$1.00 at compound interest.	Col. 3 Present worth of \$1.00 due at end of each year.	Col. 4 Present worth of an annuity of \$1.00 paid at end of each year.	Col. 5 Amount of annuity of \$1.00 paid at end of each year.	Col. 6 Annuity paid at end of each year required to amount to \$100 in different periods.
1	1.06	.943	.943	1.00	100.00
2	1.12	.890	1.83	2.06	48.54
3	1.19	.840	2.67	3.18	31.41
4	1.26	.792	3.47	4.37	22.86
5	1.34	.747	4.21	5.64	17.74
6	1.42	.705	4.92	6.98	14.34
7	1.50	.665	5.58	8.39	11.91
8	1.59	.627	6.21	9.90	10.10
9	1.69	.592	6.80	11.49	8.70
10	1.79	.568	7.36	13.18	7.59
11	1.90	.527	7.89	14.97	6.68
12	2.01	.497	8.38	16.87	5.93
13	2.13	.469	8.85	18.88	5.30
14	2.26	.442	9.30	21.02	4.76
15	2.40	.417	9.71	23.28	4.30
16	2.54	.394	10.11	25.67	3.90
17	2.69	.371	10.48	28.21	3.54
18	2.85	.350	10.83	30.91	3.24
19	3.03	.331	11.14	33.76	2.96
20	3.21	.312	11.47	36.79	2.72
21	3.40	.294	11.76	39.99	2.50
22	3.60	.277	12.04	43.39	2.27
23	3.82	.263	12.30	47.00	2.13
24	4.05	.247	12.55	50.82	1.97
25	4.29	.233	12.78	54.86	1.82
30	5.74	.174	13.76	79.06	1.27
35	7.69	.130	14.49	111.43	0.897
40	10.29	.0972	15.05	154.76	0.646
45	13.76	.0727	15.46	212.74	0.470
50	18.42	.0543	15.76	290.34	0.344
60	32.99	.0303	16.16	533.13	.188
70	59.08	.0169	16.38	967.93	.103
80	105.80	.00945	16.51	1746.60	.0573
90	189.47	.00528	16.58	3141.08	.0318
100	339.30	.00295	16.61	5638.37	0.0177
∞	∞	....	16.67	∞	....
Formula n = years	$(1.06)^n$	$\frac{1}{(1.06)^n}$	$\frac{1}{(1.06)^n} \times \frac{(1.06)^n-1}{.06}$	$\frac{(1.06)^n-1}{.06}$	$\frac{1}{(1.06)^n-1}$

A few examples may make some uses of this table more evident.

Example 1.

Find the present worth of an annual charge of $700 for 5 years, deferred 3 years. From the fourth column the present worth of an annuity of $1.00 for 8 years is $6.22, for 3 years, $2.67. The present worth of an annuity of $1.00 for 5 years, deferred 3 years, is then $6.22.—$2.67 or $3.55 and the present worth of such an annuity of $700 is $700x3.55 or $2,485.

Example 2.

Find the present worth of $800 due 6 years from date. From column 3, the factor is seen to be .705. Therefore, the present worth is $800x.705=$564.

Example 3.

Find the depreciation rate on a sinking fund basis of a machine having a life of 10 years and a salvage value at the end of 10 years of 20 per cent. From the last column we see that $7.59 set aside each year for 10 years will amount to $100. Consequently, .80x7.59%—6.072% is the depreciation sought.

Transfer Loss.

An important factor in present worth calculations is what is termed the "Transfer Loss." Whenever any piece of apparatus is removed from service before the end of its normal life, there is a transfer loss. This loss is made up of the labor and indirect charges of the original installation, the cost of removal of the plant and the inevitable shrinkage in value due to the handling and removal and the fact that the material, if all recovered and if usable again may have to remain in stock some time before it can be utilized. Transfer Loss is merely depreciation which takes place in a lump sum, instead of being spread over a term of years. The method of calculating this is illustrated by the following example: A cable in place costs $5,000 per mile and has a normal life of 12 years. If removed, a net salvage of only $750 is obtained. The cable is removed at the end of 7 years. What is the transfer loss?

Total value, subject to depreciation, $5,000—750=$4.250.

Depreciation per year—4,250 ÷ 12=$354.

Depreciation in 7 years, 7x354=$2,478.

Transfer Loss at end of 7 years, $4.250—2,478=$1.772.

Expressed algebraically:

$$\text{Transfer Loss} = C - S' - \frac{(C-S)}{(\ L\ )}\ L'$$

When C=first cost

S=Salvage at end of normal life

L=Normal life

L′=Life at end of which it is desired to figure the transfer loss.

S′=Salvage at end of L′.

It is understood that the salvage is the net salvage, namely, the gross salvage less the cost of removal.

The above method is based on the idea that the transfer loss is proportional to the time the plant has been in service, e. g., that the depreciation fund accumulates on a straight line basis, and not on a sinking fund basis. It is obviously not fair to predicate the transfer loss on a hypothetical depreciation reserve built up with an assumed rate of interest, when as a matter of fact, a depreciation reserve may never have been set aside. What is desired is the true physical transfer loss, not a theoretical figure.

In some cases, however, one of the plans may contain annual charges (including depreciation figured on a sinking fund basis) on a portion of the plant in such a manner as to necessitate using these depreciation charges in order to figure the transfer loss. Otherwise, the two courses will not be comparable.

For example, in one course, the plant is removed now. In the other course, it is retained for 3 years longer. If there is no difference in the salvage for the two cases, the difference in transfer loss is the amount of the depreciation for 3 years, but in one course this depreciation is figured as a part of the annual charges on a sinking fund basis. The other course to be comparable must figure the transfer loss on the amount of the depreciation on a sinking fund basis.

Often the transfer loss is the controlling item in the comparative charges, and its correct calculation is of great importance. It sometimes happens that a particular structure, the transfer loss on which is under calculation, has already outlived the normal life for similar structures and can be made to do service for a number of years yet. If the average depreciation were assumed to

hold, there would be no transfer loss, but perhaps a transfer "credit." In such cases, the most probable life of the structure should be taken in figuring the transfer loss. In comparative cases it is important to get accurately the difference between two transfer losses while the absolute transfer loss in each case is relatively unimportant. For example: A structure can be made to live two years longer when it will have an age of twelve years and will have to be junked. If it is wished to compare the two cases of removing the structure now, or prolonging its life for two years, the difference between the two transfer losses will be merely the accumulated depreciation on the structure for two years with an allowance for any difference in the salvage value for the two periods.

Annual Charges.

The annual charges on a physical plant are those expenses which can be readily expressed as a percentage of the cost of the plant. The Annual Charges are generally made up of some or all of the following items:

Interest
Depreciation
Taxes
Insurance
Maintenance
Administration.

It will be noticed that "operation" is not included in the annual charges. It is omitted for the reason that ordinarily, the operation has little or no easily expressed relation to the physical value of the plant, while all the other factors can be expressed as a percentage of the physical value of the plant. In many studies, of course, it is necessary to consider the cost of operation, but it is expressed as a separate item.

Interest is, of course, the interest on the money invested; 6 per cent is commonly used in engineering studies.

Depreciation covers the losses in the physical plant, due to the following factors:

1st. Ordinary wear and tear, or natural aging or decay. There has been no "fountain of youth" discovered which will stop old age.

2nd. Obsolescence.

Obsolescence may be made up of one or more of the following factors:

There is the obsolescence due to improvements in the art which render it economical to replace a structure by a more modern one before it is worn out. The replacing of a reciprocating steam engine by a steam turbine is an example of this kind of obsolescence.

There is the obsolescence due to a change in style which makes the structure of lessened value, although, it may be far from worn out. An example is the depreciation of an automobile, due to the introduction of different style of body, front doors, etc. This obsolescence is very marked in clothing.

There is also the obsolescence, especially of machinery, not due to any improvement in the machine, but due to the fact that the product of the machine has become obsolete or for economic reasons is no longer made in that locality, and the machine itself is consequently of little value. An example is the depreciation in machinery for making carbon filaments for incandescent lamps.

There is the obsolescence due to public opinion, on account of the introduction of safer or more sanitary structures. An example is the forced introduction of the steel passenger car.

3rd. Inadequacy, due to unforeseen growth; namely, the loss due to removing plant which is not worn out, but which is too small and has to be replaced with plant of greater capacity. Every public utility in rapidly growing cities experiences this loss.

4th. Loss due to removing, excess plant or plant in wrong locations, caused by faulty engineering or unexpected or unforeseen changes in growth. An example is the removal of excess plant of a public utility serving an oil town after the exhaustion of the field and the resulting loss in population.

5th. City, State or other regulations requiring the removal or changing of plant in advance of its natural life. An example is a city ordinance requiring the placing of wires underground on certain streets.

6th. Extraordinary Repairs, e. g., damage due to storm, flood, fire or accident. An example is the great loss to property in the Middle West due to the floods in the spring of 1913.

7th. There is also the depreciation due to permanent changes

in value of material and supplies. With most systems of book-keeping, this does not affect the value of the plant already in service, but does change the value of the supplies and material on hand. An example is the shrinkage in value of many articles, such as wool, sugar, lumber, etc., due to the new tariff law.

In the popular mind, depreciation is almost entirely associated with item No. 1, loss due to wear and tear or aging of the plant. As a matter of fact, this item constitutes only a small part of the total depreciation in many classes of plant, especially electrical plants, and plants of utility companies on or above city streets.

In present worth studies, depreciation should ordinarily be figured on a sinking fund basis. This statement must not be construed to mean that such is the case in rate or valuation problems, as they are an entirely different question.

Much can be written about depreciation but it is not the intention to discuss this important subject in this paper.

Taxes cover all taxes on the property.

Insurance is generally given as a separate item for such portions of the plant which are insured, such as buildings and their contents. For those parts of the plant which are ordinarily not insured, such as pole lines, wires, etc., the loss from fire, storm, etc., is included in the item of depreciation.

Maintenance covers the ordinary up-keep of the plant but does not cover the extraordinary repairs included in depreciation.

Administration covers that portion of the executive expenses which is properly charged to maintaining and keeping up the plant. It is generally a very small part of the annual charges.

The above annual charges are generally from 10 to 30 per cent of the cost of the plant. The lower percentages are true of such parts of the plant as land, fire-proof buildings, clay, conduits, etc., and the higher percentages for the shorter lived parts, such as electrical machines, aerial wire, etc.

One or two examples will now be given to illustrate the foregoing ideas:

Problem:

I now own a building which cost $100,000 on a lot which cost $10,000. It is necessary to make an extension to the building to care for the growth in business. If I make the addition it is estimated that it will last only until January 1, 1920, when

a new building must be erected, since a building restriction will not allow adding any more stories to present building and no additional ground space can be secured.

Should I erect the new building now or add to the present building?

The present lot and building are so situated that I cannot obtain in the market as much as they originally cost.

Figures Assumed:

Cost of present building	$100,000
Cost of present lot	10,000
Cost of extension	50,000
Estimated amount which could be secured for present lot and building to-day (1-1-15)	90,000
Estimated amount which could be secured five years hence for lot and building after additions	110,000
New lot	10,000
New building	200,000
Annual charges on lots assumed	*8½%
Annual charges on buildings assumed	†11½%

*Annual Charges on Lot.

Interest	6%
Taxes	1.5%
Administration	1.0%
Total	8.5%

†Annual Charges on Bldg.

Interest	6%
Maintenance	1%
Insurance	.75%
Taxes	1.5%
Administration	1.0%
Depreciation	1.25%
Total	11.50%

Plan I

Add to present building and in 1920 buy a new lot and erect new building.

Present Worths taken from January 1, 1915, to January 1, 1920.

Nature of Work.	Cost.	Period.	Annual Charges. %	Amount.	Factor.	Present Worth.
Present Building	$100,000	1-1-15 to 1-1-20	11.5	$11,500	4.22	$48,530
Present lot	10,000	1-1-15 to 1-1-20	8.5	850	4.22	3,587
Addition to bldg.	50,000	1-1-15 to 1-1-20	11.5	5,750	4.22	24,265
Transfer loss	50,000	1-1-20	.....	....	.747	37,350
						$113,732

Transfer Loss:

Cost of lot	$ 10,000
Cost of building	100,000
Cost of addition	50,000
	$160,000
Sale value in 1920	110,000
	$ 50,000*

*In calculating this transfer loss it is assumed that the old building has been maintained in condition substantially as good as new, e. g., so that there is no accrued depreciation on it.

Plan II

Present lot and building is sold and new lot secured and new building erected.

Present Worths taken from January 1, 1915, to January 1. 1920.

Nature of Work.	Cost.	Period.	Annual Charges. %	Amount.	Factor.	Present Worth.
New lot	$ 10,000	1-1-15 to 1-1-20	8.5	$ 850	4.22	$ 3,587
New building	200,000	1-1-15 to 1-1-20	11.5	23,000	4.22	97,060
Transfer loss	20,000	1-1-15	......	....	1.0	20,000
						$120,647

Transfer Loss:

Present lot	$ 10,000
Present building	100,000
	$110,000
Present market value	90,000
	$20,000*

*The same remark as to transfer loss applies as under Plan 1.

From these figures it is seen that the plan for erecting a new building at once is approximately $7,000 the more expensive. It may be, of course, that there are some advantages of Plan 2 which have not and cannot well be evaluated and which may be worth this $7,000 difference. Some of these, for example, might be the advantage of occupying a new structure, presumably, better arranged than the old, 5 years in advance of Plan 1, the value of advertising due to the use of a new building, etc. The result of the present worth calculations is, merely, a comparison of all the factors upon which a reasonable valuation can be placed. This result must then be weighed against any other con-

sideration of policy, or factors which are more or less intangible and which cannot be expressed in figures. Unless the final answer is taken from such a broad viewpoint, the study is of little value.

A certain plant costs $14,000 of which $10,000 is the cost of equipment and material and $4,000 the indirect charges and cost of installation. It has a life of 10 years. It is possible to buy secondhand apparatus for $6,000 which will also cost $4,000 to install, but this apparatus will only last for 5 years. There will be no salvage on either kind of plant. Which is the cheaper plan, to install new material or secondhand?

Plan 1—Use Second Hand Material:

Nature of Work.	Cost.	Period.	Annual Charges. %	Annual Charges. Amount.	Factor.	Present Worth.
Install second hand material	$10.000	5 yrs.	27.7*	$2,770	4.22	$11,689
Totals						$11,689
Install new apparatus	$14,000	5 yrs.	17.6†	$2,464	4.22	$10,398
Total						$10,398

*Plan I

Depreciation (5-year life, no salvage)	17.7%
Other charges	10%
Total	27.7%

†Plan II

Depreciation (10-year life, no salvage)	7.6%
Other charges	10%
Total	17.6%

It will be noticed that at the end of the period under study, there is the same amount of plant in equivalent condition under each plan. With Plan 1, after the old plant is worn out, a new plant is erected. In Plan 2, the new plant is five years old, but there is a sufficient reserve in the depreciation fund to care for the loss in value. So. in one case we have a new plant with no depreciation reserve, and in the other case, a plant 5 years old with a 5-year depreciation reserve.

Mathematical Notation:

For those who are interested in studying the problem of present worth from a mathematical point of view, the following notation is suggested:

Present worth will be indicated by PW.

A sub-letter will indicate the time deferred.

Thus PWa_n indicates the present worth of a deferred n years.

$PW\Sigma_y a$ indicates the present worth of an annuity of a for y years.

$PW\Sigma_y a_n$ indicates the present worth of an annuity of a for y years, deferred n years.

Since the present worth of any sum equals that sum times the present worth of unity for the same period, we have:

$$PWa_n = aPW1_n$$
$$PW\Sigma_y a = aPW\Sigma_y 1$$
$$PW\Sigma_y a_n = aPW\Sigma_y 1_n$$

From Table 1, Column 4, we see that $PW\Sigma_\infty 1 = 16.67$.

General Notes.

Period Covered by Study:

The period covered by the study should be the same for each of the cases under comparison and should be such that at the end of the period the plant for all cases is the same. If this is not done, the comparison is obviously unfair. For example, two courses may be compared so that one shows a lower annual charge for the period in question than the other, but the first course completes the period with a plant of greater capacity than the second course. No comparison is accurate which does not take into consideration this inequality in plant.

Plant at End of Period:

It sometimes happens that at the end of the study, the several courses under discussion will all have plant of the same capacity, but of different replacement values. For example, one plan may have at the end of the period one 200-pair cable on a pole line, while the other plan may have two 100-pair cables on the same line. The capacity is the same, but the cost, and consequently, the annual charges on the two 100-pair cables, are considerably greater than those of the single 200-pair cable.

It is obvious that other things being equal that course is preferred which results in the plant with the smallest annual charges. Consequently, it is fair to charge against the course involving the two 100-pair cables the present worth of the extra annual

charges on such plant for the probale time it will remain in service. An example may make this clear:

Suppose the study covers a period of five years, the total annual charges for which period are:

1st. For the two 100-pair cable case............................$3,000
2nd. For the one 200-pair cable case............................ 3,200

The investment at the end of the period is $500 greater with the 100-pair cables, and it seems likely that the plant will be maintained in either case for at least ten years. The annual charges are 17 per cent, or the extra annual charge on the two 100-pair cables is .17x500=$85.

The present worth of an annuity of $85 deferred five years and running for ten years is $467, which, added to $3,000, will make the Plan 1 the more expensive.

Annual Charges and Capital Expenditures:

In present worth studies care must be taken not to confuse *annual charges* with capital expenditures. The annual charges should not be added to capital expenditures in making comparisons. This is an error which the beginner is very liable to fall into and which will almost always cause misleading results. The reason for this is that the annual charges included depreciation and interest and if this is added to the capital expenditures, a duplication occurs. The charges are dissimilar and cannot be added together.

Value and Practical Use of Present Worth Studies:

A present worth calculation is of no value unless it is carefully and intelligently made and free from errors. It sounds like a truism to make such a remark, but those who have had any experience with involved present worth studies will realize that it is extremely easy to make a study which is misleading and which does not reflect the truth. Often the work is so laborious and so involved or technical that your superior will not take the time to check the detail figures. If the result does not agree with his "common sense," he will quite likely reject it. Great care should be taken not to let the personal equation or inclination of the engineer or his superiors bias the figures. This is often hard to avoid, even with the most conscientious of engineers. It is very important that any study involving somewhat laborious present worth calculations be reviewed in a broad manner,

measuring the result by the yard-stick of common sense, and if the measure is lacking the study should be carefully checked.

With such a check, and after one has become sufficiently expert in present worth studies to have confidence in his results, they serve as an extremly important tool in the solution of many involved problems. By their aid, the answer can be partially expressed in dollars and cents, a method which is especially desirable when presenting the case to executive officials for their final approval.

If an official has a concise statement in intelligent English of the various alternatives involved, a statement of the capital expenditures of each course, and the annual charges of each course, together with a statement of any questions of policy involved, and those intangible values which cannot be expressed in dollars and cents, if he has all this information intelligently presented, the answer is generally not far to seek.

Table 2.

TABLE OF PRESENT WORTHS.

Figured at 5 per cent interest compounded annually.

Col. 1 Years.	Col. 2 Amount at end of each year of $1.00 at compound interest.	Col. 3 Present worth of $1.00 due at end of each year.	Col. 4 Present worth of an annuity of $1.00 paid at end of each year.	Col. 5 Amount of annuity of $1.00 paid at end of each year.	Col. 6 Annuity paid at end of each year required to amount to $100 in different periods.
1	1.05	.952	.952	1.00	100.00
2	1.10	.907	1.86	2.05	48.78
3	1.16	.864	2.72	3.15	31.72
4	1.22	.823	3.55	4.31	23.20
5	1.28	.784	4.33	5.53	18.10
6	1.34	.764	5.08	6.80	14.70
7	1.41	.711	5.79	8.14	12.28
8	1.48	.677	6.46	9.55	10.47
9	1.55	.645	7.11	11.03	9.07
10	1.63	.614	7.72	12.58	7.95
11	1.71	.585	8.31	14.21	7.04
12	1.80	.557	8.86	15.92	6.28
13	1.89	.530	9.39	17.71	5.64
14	1.98	.505	9.90	19.60	5.10
15	2.08	.481	10.38	21.58	4.66
16	2.18	.458	10.84	23.66	4.23
17	2.29	.436	11.28	25.84	3.87
18	2.41	.415	11.69	28.13	3.55
19	2.53	.396	12.08	30.54	3.27
20	2.65	.377	12.46	33.07	3.02
21	2.79	.359	12.82	35.72	2.80
22	2.93	.342	13.16	38.51	2.60
23	3.07	.325	13.49	41.43	2.41
24	3.23	.310	13.80	44.50	2.25
25	3.39	.295	14.09	47.73	2.10
30	4.32	.231	15.37	66.44	1.51
35	5.52	.181	16.37	90.32	1.11
40	7.04	.142	17.16	120.80	.827
45	8.99	.111	17.77	159.70	.626
50	11.47	.0872	18.26	209.35	.478
60	18.70	.0535	18.93	353.58	.283
70	30.43	.0329	19.34	588.53	.170
80	49.56	.0202	19.60	971.23	.103
90	80.73	.0124	19.75	1594.61	.0627
100	131.50	.00760	19.85	2610.03	.0383
∞	∞	....	20.00	∞	....
Formula n = years	$(1.05)^n$	$\frac{1}{(1.05)^n}$	$\frac{1}{(1.05)^n} \times \frac{(1.05)^n-1}{.05}$	$\frac{(1.05)^n-1}{.05}$	$\frac{5}{(1.05)^n-1}$

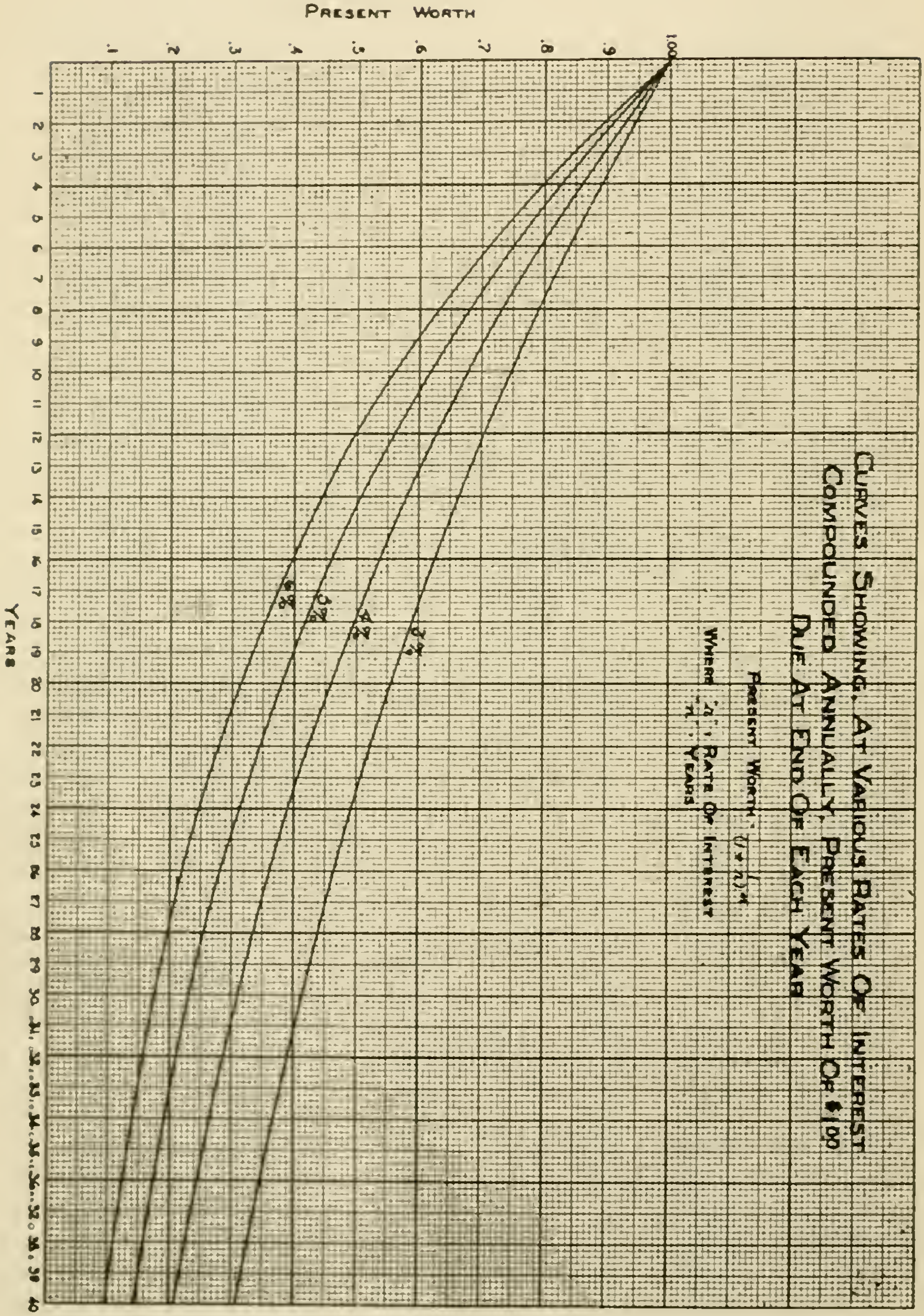
Table 3.
TABLE OF PRESENT WORTHS.

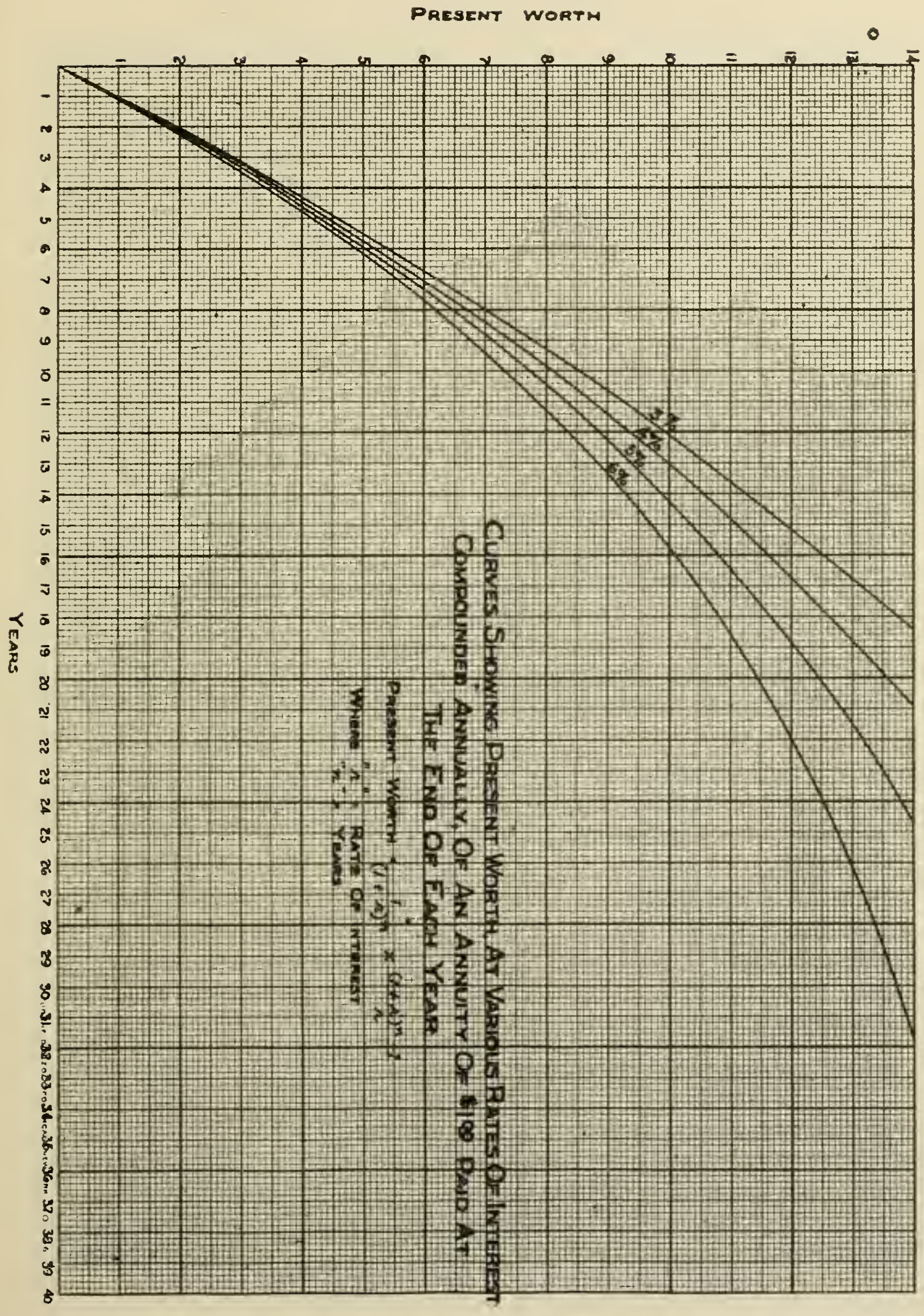
Figured at 4 per cent interest compounded annually.

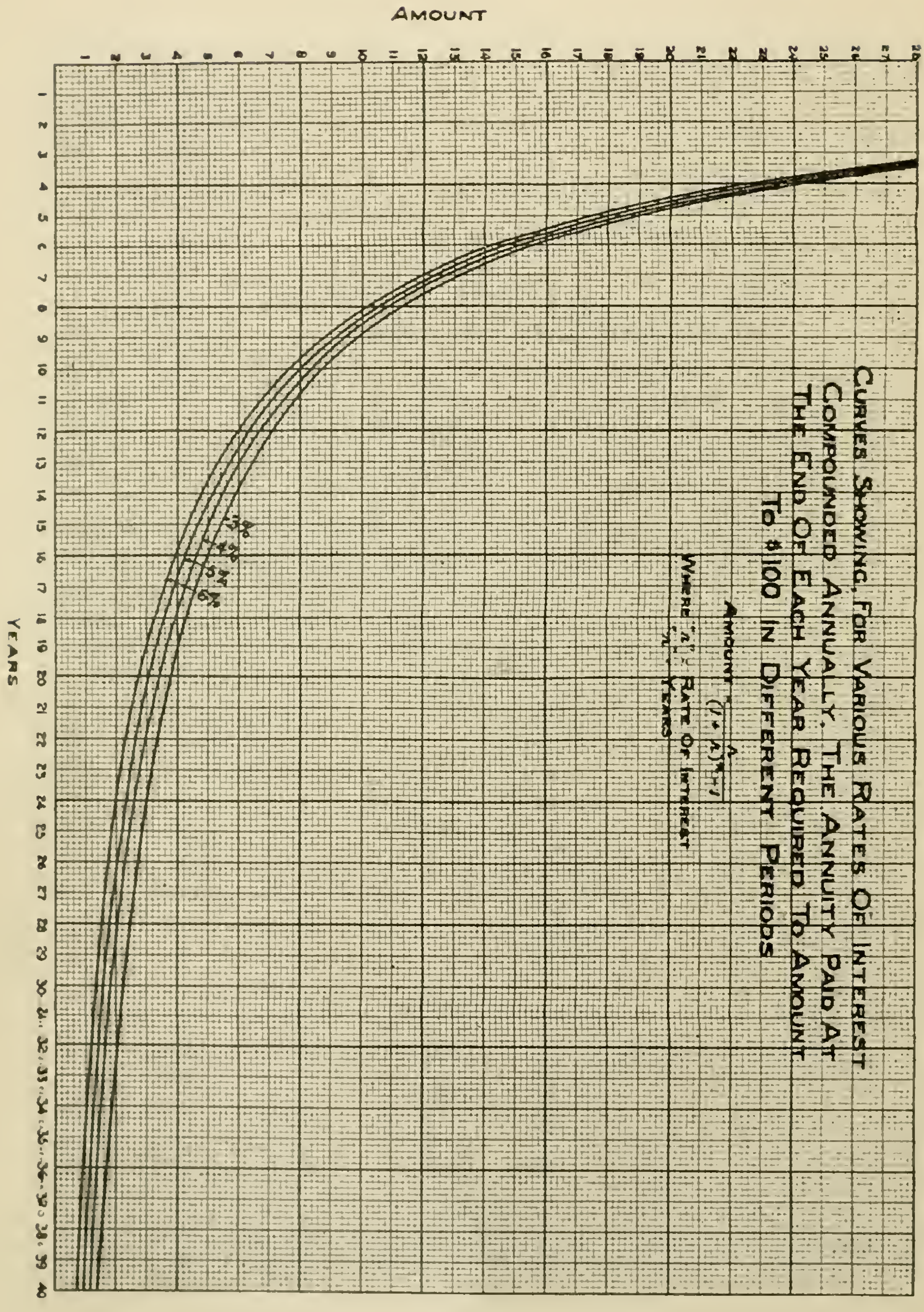
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Years.	Amount at end of each year of $1.00 at compound interest.	Present worth of $1.00 due at end of each year.	Present worth of an annuity of $1.00 paid at end of each year.	Amount of annuity of $1.00 paid at end of each year.	Annuity paid at end of each year required to amount to $100 in different periods.
1	1.04	.962	.962	1.00	100.00
2	1.08	.925	1.89	2.04	49.02
3	1.12	.889	2.78	3.12	32.03
4	1.17	.855	3.63	4.25	23.55
5	1.22	.822	4.45	5.42	18.46
6	1.27	.790	5.24	6.63	15.08
7	1.32	.760	6.00	7.90	12.66
8	1.37	.731	6.73	9.21	10.85
9	1.42	.702	7.43	10.58	9.45
10	1.48	.676	8.11	12.01	8.33
11	1.54	.650	8.76	13.49	7.42
12	1.60	.625	9.39	15.03	6.66
13	1.67	.601	9.99	16.63	6.01
14	1.73	.577	10.56	18.29	5.47
15	1.80	.555	11.12	20.02	4.99
16	1.87	.534	11.65	21.82	4.58
17	1.95	.513	12.17	23.70	4.22
18	2.03	.493	12.66	25.65	3.90
19	2.11	.475	13.13	27.67	3.61
20	2.19	.456	13.59	29.78	3.36
21	2.28	.439	14.03	31.97	3.13
22	2.37	.422	14.45	34.25	2.92
23	2.46	.406	14.86	36.62	2.73
24	2.56	.390	15.25	39.08	2.56
25	2.67	.375	15.62	41.65	2.40
30	3.24	.308	17.29	56.08	1.78
35	3.95	.253	18.66	73.65	1.36
40	4.80	.208	19.79	95.03	1.05
45	5.84	.171	20.72	121.03	.826
50	7.11	.141	21.48	152.67	.655
60	10.52	.0951	22.62	237.99	.420
70	15.57	.0642	23.39	364.29	.275
80	23.05	.0434	23.91	551.24	.181
90	34.12	.0293	24.26	827.98	.121
100	50.50	.0198	24.50	1237.62	.0808
∞			25.00	∞	
Formula n = years	$(1.04)^n$	$\frac{1}{(1.04)^n}$	$\frac{1}{(1.04)^n} \times \frac{(1.04)^n-1}{.04}$	$\frac{(1.04)^n-1}{0.4}$	$\frac{(1.04)^n-1}{4}$

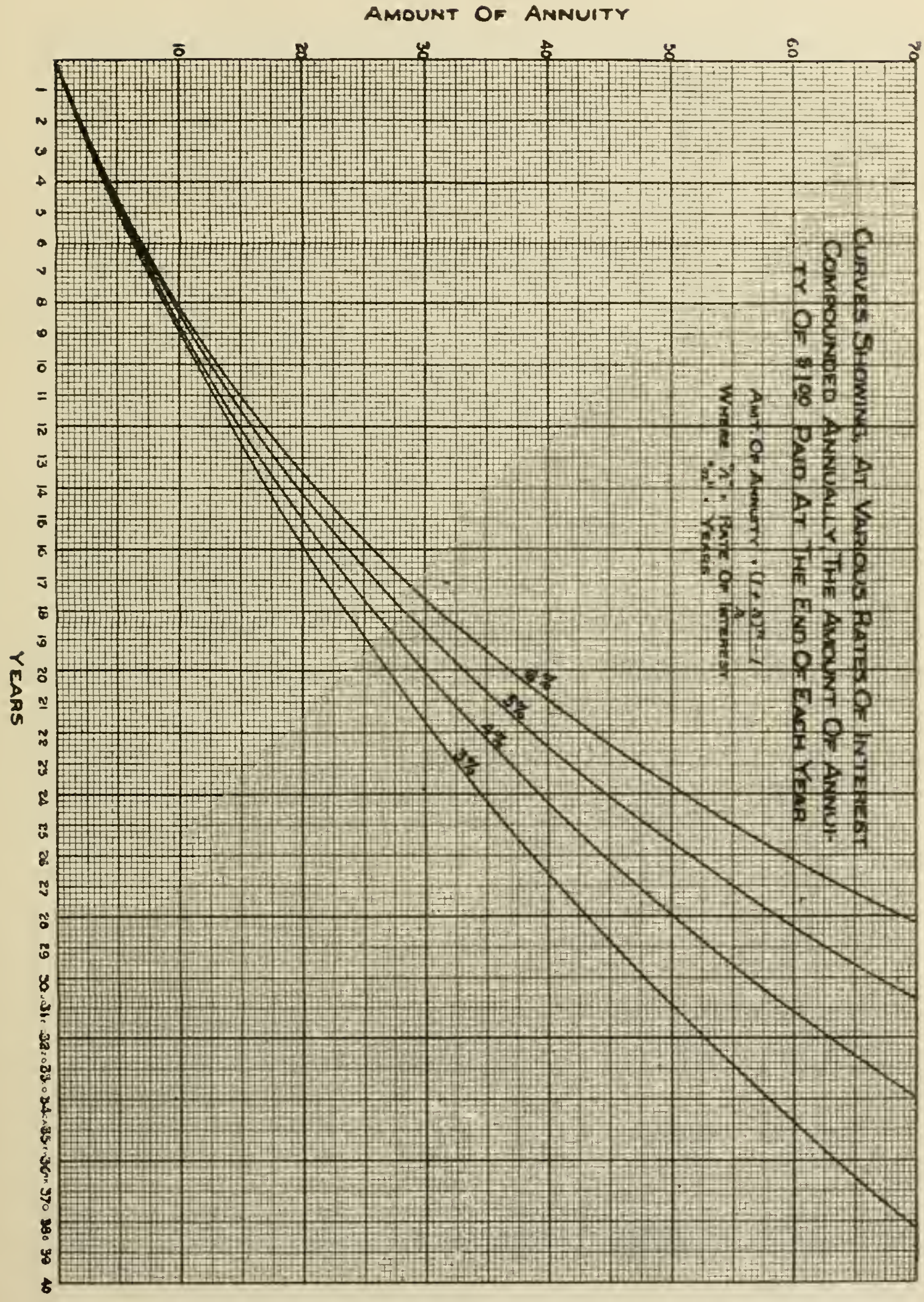
Table 4.
TABLE OF PRESENT WORTHS.
Figured at 3 per cent interest compounded annually.

Col. 1 Years	Col. 2 Amount at end of each year of $1.00 at compound interest.	Col. 3 Present worth of $1.00 due at end of each year.	Col. 4 Present worth of an annuity of $1.00 paid at end of each year.	Col. 5 Amount of annuity of $1.00 paid at end of each year.	Col. 6 Annuity paid at end of each year required to amount to $100 in different periods.
1	1.03	.971	.971	1.00	100.00
2	1.06	.943	1.91	2.03	49.26
3	1.09	.915	2.83	3.09	32.35
4	1.13	.888	3.72	4.18	23.90
5	1.16	.863	4.58	5.31	18.84
6	1.19	.837	5.42	6.47	15.46
7	1.23	.813	6.23	7.66	13.05
8	1.27	.789	7.02	8.90	11.25
9	1.30	.766	7.79	10.16	9.84
10	1.34	.744	8.53	11.46	8.72
11	1.38	.722	9.25	12.81	7.81
12	1.43	.701	9.95	14.19	7.05
13	1.47	.681	10.64	15.62	6.40
14	1.51	.661	11.30	17.09	5.85
15	1.56	.642	11.94	18.60	5.38
16	1.60	.623	12.56	20.16	4.96
17	1.65	.605	13.17	21.76	4.60
18	1.70	.587	13.75	23.41	4.27
19	1.75	.570	14.32	25.12	3.98
20	1.81	.554	14.88	26.87	3.72
21	1.86	.537	15.41	28.67	3.49
22	1.92	.522	15.93	30.54	3.27
23	1.97	.507	16.44	32.45	3.08
24	2.03	.492	16.93	34.43	2.90
25	2.09	.478	17.41	36.46	2.74
30	2.43	.412	19.60	47.57	2.10
35	2.81	.355	21.49	60.46	1.65
40	3.26	.306	23.11	75.40	1.33
45	3.78	.264	24.52	92.72	1.08
50	4.38	.228	25.73	112.79	.887
60	5.89	.170	27.68	163.05	.613
70	7.92	.126	29.13	230.59	.434
80	10.64	.0939	30.20	321.36	.311
90	14.30	.0699	31.01	443.35	.226
100	19.22	.0520	31.60	607.29	.165
∞	∞	....	33.33	∞	....
Formula n = years	$(1.03)^n$	$\frac{1}{(1.03)^n}$	$\frac{1}{(1.03)^n} \times \frac{(1.03)^n-1}{.03}$	$\frac{(1.03)^n-1}{.03}$	$\frac{3}{(1.03)^n-1}$


Present Worth
Years
Curves Showing, At Various Rates Of Interest Compounded Annually, Present Worth Of $1.00 Due At End Of Each Year
Present Worth = $\frac{1}{(1+r)^n}$
Where r = Rate Of Interest
n = Years
6%
5%
4%
3%


PRESENT WORTH
YEARS
Curves Showing Present Worth At Various Rates Of Interest Compounded Annually, Of An Annuity Of $100 Paid At The End Of Each Year
3%
4%
5%
6%
Where "r" = Rate Of Interest
"n" = Years


AMOUNT
YEARS
Curves Showing, For Various Rates Of Interest Compounded Annually, The Annuity Paid At The End Of Each Year Required To Amount To $100 In Different Periods
Amount = $\frac{r}{(1+r)^n - 1}$
Where "r" = Rate Of Interest
"n" = Years
3%
4%
5%
6%


AMOUNT OF ANNUITY
10
20
30
40
50
60
70
YEARS
CURVES SHOWING, AT VARIOUS RATES OF INTEREST COMPOUNDED ANNUALLY, THE AMOUNT OF ANNUITY OF $1.00 PAID AT THE END OF EACH YEAR
6%
5%
4%
3%

DISCUSSION.

Mr. L. Gutman. I would like to ask how your percentages are derived.

Mr. W. O. Pennell. They are derived from a study which the engineer will have to make of the different parts of the plant under consideration. We know the interest is so much, and the taxes so much, if there are any, and there are very few things that are not taxed, and there is a charge for administration; a charge for depreciation, etc., and they go to make up what I have termed in the paper, the annual charges. Of course, the correct determination of these charges is, so to speak, the gist of the whole thing. It is easy to make the annual charge 20, 25 or 30 per cent, but the real answer to your problem, whether it is yes or no, depends on the correctness of your annual charges.

Mr. W. C. Swartout. In this case, you have assumed the salvage value as $750?

Mr. W. O. Pennell. Yes. I have assumed that the salvage when the cable is removed at the end of seven years is no more than the salvage if the cable were not removed until the end of twelve years. This is frequently the case with certain kinds of cable which often have to be junked when removed after having been in service as long as seven years. It is obviously not true as a general proposition, as ordinarily you would expect a greater salvage value at seven years than at twelve years. In the algebraic expression of the transfer loss, I have taken this into consideration and have used two different symbols for the salvage at the two different periods.

Mr. C. E. Brenton. How long is the $200,000 building going to last?

Mr. W. O. Pennell. It is supposed to care for the growth for an indefinite period. I suppose you would build it on the unit type so, if you have enough land, it can be extended. That is the way the engineer would ordinarily figure. Perhaps he would make a mistake in his growth.

Mr. John Hunter. How do you allow quite that high a figure for the old building, $110,000 in 1920?

Mr. W. O. Pennell. It is on account of the extension, and I have assumed that property has gone up.

Mr. John Hunter. The building would be put up there for

a special purpose and might not be worth the value at that time. If you had to move to a new building, it is more than likely the building could not be used for the same purpose for which you had been using it.

MR. W. O. PENNELL. Possibly so. My figures are merely assumptions, which might happen. of course. The figures were used to illustrate a principle and no matter what exact salvage value is assumed for the old building, the principle involved is the same.

MR. H. F. MERKER. Does that include the land?

MR. W. O. PENNELL. Yes. To-day, we can dispose of this, which cost us $110,000 for $90,000. That is $20,000 less than what it cost us. In five years, with the addition, we can dispose of what has cost us $160,000 for $110,000, which is $50,000 loss.

MR. C. E. BRENTON. Why do you use the same factor for the old building and the extension?

MR. W. O. PENNELL. The "factor" merely represents the figure which multiplied into the annual charges will represent the present worth of the annual charges for, in this case, five years. Obviously this factor is in no way related to any particular part of the building as long as the annual charges are taken for the same period over the structure.

MR. JOHN HUNTER. You get the same salvage from the new extension as you would from the old?

MR. W. O. PENNELL. I do not know, Mr. Hunter, I don't imagine you would. I imagine if you had a building and you added something to it, that additional probably would bring you very little if you care to sell the building,—that is, if it were a building constructed for some special use, and you would have to consider that in your figures for the transfer loss.

MR. H. F. MERKER. If you put up a building for $50,000 for five years, would not it probably be of such a construction that there would be a higher annual charge?

MR. W. O. PENNELL. Yes, you could consider that, if you want to, two ways. You can assume that the annual charges are the same and there is a greater transfer loss on the building which lasts only 5 years, or you can assume the depreciation is such it will all be paid for in five years. In that case, you would not have so much transfer loss, because you would not have any transfer loss on your addition, it being taken care of in your annual charges. I have chosen to say that the annual charges on

the two buildings, which are similar, were the same, and this building which lasts only five years, contributes a considerable portion to this transfer loss. Either result would bring you out the same way, provided you used comparable figures.

Mr. H. F. Merker. I only mentioned that to draw out whether or not it would necessarily be the same figure.

Mr. W. O. Pennell. If you figure your depreciation, this alternative way, it would be, then, a larger figure than I have used, but on the other hand the transfer loss would have to be estimated accordingly. The net result would be the same.

Mr. H. F. Merker. You are only guessing, then?

Mr. W. O. Pennell. The answer to many engineering questions is a scientific guess. You analyze your guess into a lot of small parts so if there is any error it will be spread over a little here and there, and you are likely to err on one side here and another side there, so when you put them together one error will fill up the hole of the other.

Mr. John Hunter. About the 11½% annual charge for the new building. Would not that be high? You would expect it to last 50 or 75 years?

Mr. W. O. Pennell. When you get your obsolescence and other features in you will find that they do not last as long as that. Of course, if you use just physical wear and tear, the building would last several hundred years, but probably you outgrow it or, if you built it on the unit plan, you may be unable to obtain ground to extend it, or maybe there will be an act of God, —a cyclone,—and it will be blown down, or something of that sort. I have generally used a factor a little higher than that on new buildings and I do not think that is really a high charge.

Mr. John Hunter. The possibilities would be better for the new building than the old one, in most cases.

Mr. W. O. Pennell. You understand I have merely taken a typical case. It is perfectly possible that for many cases the annual charges may be lower and for other cases the charges may be higher than the figure I have used. You could make it less and make a very pretty problem. I did not take any actual problems, because they involve a good many technicalities in my own line of work, which I did not think would appeal to most of you.

The present worth of an annual charge may be explained more clearly by the following example: Suppose I have $48,530

in a bank, drawing compound interest at the rate of 6 per cent. I could then draw a check at the end of each year, for five years, to the amount of $11,500, and at the end of five years I would not have anything left in the bank; namely, the last check would have used up all the balance. In other words, $48,530 is the present worth at 6 per cent of an annual charge for five years of $11,500. As another illustration: if you should place at 6 per cent compound interest $37,350, at the end of five years it would have amounted to $50,000. In other words, $37,350 is the present worth, at 6 per cent, of a charge of $50,000, deferred five years. The above two examples are taken from the problem which I explained in my paper regarding the economy of extending an existing building or erection of a new building at once.

MR. C. L. JENNINGS. The funny thing to me is, it seems that the salvage to-day and your present worth to-day ought to be nearer. Your salvage to-day is $90,000 and the present worth of that building and land to-day is about $52,000 according to your calculations there.

MR. W. O. PENNELL. The building cost, new, $100,000 and the lot, $10,000, and the salvage to-day is $90,000.

MR. C. L. JENNINGS. It seemed to me this was more a calculation of value in 1920 than to-day.

MR. W. O. PENNELL. It costs you, to carry the building, $11,500 a year. You have to pay interest on it, taxes on it, you have to maintain it, and a part of the executive officials' expenses is chargeable against it. You have to meet all of these charges, and they amount to $11,500 a year. The present worth of this annual expense for five years is $48,530.

MR. V. K. HENDRICKS. In discussing a paper of this kind, I should like to have the paper and time to study over it. There is one thing that I have been a little surprised at sometimes, and that is in figuring up cross-tie economy on railroads there seemed to be so many different methods used and very few correct methods,—in my opinion. The general custom, I think, is to use tables that give the annual charge, based on an infinite period, and I think that is entirely wrong for a thing of that sort, because we are not going to use the same kind of cross-ties; that is, there will be improvements or changes in ties. I am very glad, indeed, to have been here to have heard this paper and will study it over

a good deal, because I think there should be some better method than is usually employed for figuring up that item.

Mr. C. A. Hobein. There is one very interesting use that I have found for present worth calculation. It has been used a great deal in valuation work in estimating the intangibles. For instance, a public service corporation will have a franchise which expires, say in 30 years; the engineer will estimate the future ing expenses. maintenance, depreciation, taxes and interest charges on the physical value of the property are deducted; he will then obtain the present worth of these future net earnings: the deduct from the present value of the future net earnings the present value of the future interest charges on the increased capital necessary to produce the increased earnings; the present value of the balance would represent the value of the intangibles. It is often interesting to calculate the intangibles that way and compare them to the intangibles as estimated.

Mr. W. O. Pennell. I had a rather interesting problem at one time, which I will outline briefly. I do not remember the exact figures, but the approximate amounts will illustrate the principle. There was a piece of property which was leased a number of years ago, and the lease had, we will say, 75 years yet to run. The property was leased at a time when the land was not nearly as valuable as it is now, and the annual rental throughout the life of the lease was $10,000. However, the city has grown up around the property,— it has appreciated,—the property, to-day, could be sublet for $25,000. The problem was the present value of that leasehold. Looking at the problem from an academic point of view, I reasoned that I could get $15,000 a year more for the leasehold than I was paying for it. Consequently, the leasehold should be valued as the present worth of an annuity of $15,000 for 75 years, this being the period which the lease had to run. This amounted to approximately $350,000, and I consequently concluded that the leasehold was worth that amount. Afterwards I explained the problem to a real estate man, pointing with some pride to my solution. After careful consideration, he come to the conclusion that, as a matter of fact, with the present market prices, he would probably be unable to obtain as much as $350,000 for the leasehold. This method of arriving at the value of the leasehold, however, served a good purpose. It was rather difficult to pick flaws in the reasoning,

and, as a matter of fact, it served to make the real estate people increase their valuation which they would otherwise have placed on the leasehold.

Mr. J. D. von Maur. Did you take into consideration the fact that if there had been an increase of $15,000 in five years, in 75 years there might be a still larger increase in value?

Mr. W. O. Pennell. I took that into consideratian and said that before the expiration of the lease, 75 years from now, it might be worth $40,000 or $50,000 a year, but the real estate man said while that might be true, as a matter of fact, he did not think we could sell it for $350,000. Of course, we could not beat that argument, as he knew more about real estate values than I did. My tables served this purpose: they enabled me to get some line on what the leasehold should be worth without having any previous personal knowledge of the value of the leasehold.

Mr. A. P. Greensfelder. The thought that Mr. Hendricks mentioned of different ties, reminded me of a statement by Mr. Cunningham, Chief Engineer of the Wabash Railroad, when he gave a paper before this Club several years ago on the construction of railroad shops at Decatur, Illinois. He favored his company putting up nothing but temporary buildings which would last about 25 years, stating that his experience had been that, with the consolidation of various railroads in the West and the changing of division points, permanent buildings were not warranted.

Mr. J. B. Van Vleck. I did not quite understand why Mr. Pennell used a different figure on his transfer loss. He used the figure 3 in his factor.

Mr. W. O. Pennell. In this case, I had an annual charge of for five years. That is, to maintain and keep up this property cost me so much a year for five years. Now, the present worth of that is not five times the annual charge, because some of the payments are in the future, but it is only 4.22 times the charge. In the other case, I had a lump charge to expense at the end of five years. It was not an annual charge, but it was a single charge at the end of the period. One is the present worth of an annuity and the other is the present worth of a sum deferred a certain length of time.

Mr. J. B. Van Vleck. If you set aside money you generally get 3 per cent for it, and when you require capital and borrow money you have to pay more than 6 per cent for it, so the flat

use of 6 per cent right through does not seem to balance. In one case you are setting aside the rate of 6 per cent and in another case it is sort of charging 6 per cent.

Mr. W. O. Pennell. Of course, if you used a different percentage, it would complicate the problem some, but, as a matter of fact, I think nearly every concern which lays aside a depreciation invests it in the plant and does not carry it in a sinking fund, and in the plant it will ordinarily earn what the plant pays in dividends, so I think it is probably fair enough to use the same percentage. You might question the 6 per cent charges, and say they should be 5 per cent. The tables are given for 5 per cent as well as 6 per cent. I am afraid, however, if you should try to differentiate it would complicate your calculations and, in most cases, you would not be justified in doing it. When you lay aside your depreciation it generally goes in the plant, invested as a reserve plant and earns what the plant will earn.

Mr. John Hunter. One point that Mr. Pennell spoke of in connection with depreciation, obsolescence and advance in the art has come very clearly to my notice. This is in respect to the obsolescence of machinery which it becomes necessary to replace, not because the machine has become obsolete from economic reasons, but because the machine is inadequate and inefficient. That point came very clearly before me in 1907. In 1904 we installed four 5,000 kw. turbines, with a rating of 20½ lbs. of water, and in 1907 we required a greater capacity. It was possible to get a unit with a higher capacity and higher efficiency and, after the first units had been in service for three years, it paid our company to remove the 5,000 kw. turbines and replace them with 12,000 kw. machines. This change reduced the water consumption from 20½ lbs. to 15 lbs., so that we were not only gaining in capacity but also in efficiency and the results were very marked. While it cost the company a good deal of money in making that change, we found that it was worth while and we were getting higher efficiency and higher capacity.

In the case of the depreciation of engines, of course, even those units that were taken out were in good shape. They had not depreciated as far as wear and tear were concerned. Some of the engines we have now might last 20 years without any great depreciation, as far as wear of the units themselves is concerned, and in that case naturally it is a question of obsolescence and advance in the art, that would warrant us, at this stage of

the game, to make any great changes, but we have found that it is to our interest to make these changts, even at a very high cost in doing so.

Mr. Stanley Stokes. I had an experience while making a comparison of the costs of two proposed cable lay-outs which exemplifies the point mentioned by Mr. Pennell that, in comparing the present worth of things it is always necessary to see that the things themselves are comparable. In this particular case, which was a comparison of 6,600 and 13,200 volt transmission, the one system had better voltage regulation than the other, and before the two could be compared on the basis of present worth the voltage regulation would have to be capitalized in dollars, which could hardly be done with any degree of accuracy.

Mr. W. O. Pennell. That is a very true remark. In all comparative studies you have to wind up with the same or comparable plants. Where you cannot evaluate an advantage like that mentioned of better voltage regulation, you must not lose sight of it, but must use it as an intangible factor which will influence your interpretation of the figures.

Mr. C. A. Renard. One interesting feature, which might fall in the "common sense yardstick" class, is the effect a replacement may have on a corporation's depreciation reserve and through it on the return on capital invested.

In several recent rate cases public service commissions have arrived at the "value" on which the corporation would be allowed to earn by adding to the appraised depreciated value of physical property the corporation's depreciation reserve as shown on its books. From this it would seem advisable to conserve the depreciation reserve as far as possible, which adds one more consideration to the number which, together with relative economy, are important in determining whether a unit of equipment shall be replaced.

Mr. V. K. Hendricks (*By letter.*) This paper is an interesting and valuable contribution on a subject which, unfortunately, is frequently not given the attention it should have in engineering work. The intelligent selection between alternate propositions from a business standpoint is, of course, of the most vital importance in all engineering work.

This paper presents the matter in a comprehensive way, but the writer is not entirely clear in regard to one or two features. For example, the problem as to whether a $50,000 addition

should be made to an existing $100,000 building, or whether a new building should be constructed at once at a cost of $200,000, appears either to not be completely stated, or else there are some other features which should be taken into consideration in the calculations, and which would change the result of the calculation. As stated in the paper, there should, in any problem, be the same amount of plant equivalent under each plant at the end of the period under consideration. In order to make the calculation of this particular problem correct, it should, therefore, be specified in stating the problem that the proposed new $200,000 building would last until January 1, 1920, when a new building must be erected to correspond with the new building required in case the $50,000 extension were made.

With the problem as stated, it would seem probable that the $200,000 building would either serve the requirements for more than five years, or else that the building would be so constructed that it could be enlarged with much less expense than could the new building be constructed after January 1, 1920, under Plan 1. In such event the difference between the cost of constructing an entirely new building after January 1, 1920, as required under Plan No. 1, and the cost of extending the new $200,000 building to the same capacity under Plan No. 2 should be taken into consideration in Plan No. 1, and this would probably increase the present worth under Plan No. 1 to exceed the present worth under Plan No. 2.

It also seems incorrect in Plan No. 1, as worked out in the paper, to include the 1.25 per cent charges for depreciation in the amount of the annual charges, (the writer assuming that the 1 per cent for maintenance takes care of maintaining the building in condition substantially as good as new) on account of the fact that the sale value in 1920, which is used in determining the transfer loss, takes the depreciation into consideration. The solution as given, therefore, appears to duplicate the item of depreciation.

In regard to present worth calculations as compared with annual charge calculations, the writer does not see any material advantage of one method over the other, as either method, when properly applied, should give the same relative results as the other. In cases, however, where the calculations cover continuous operations, such as renewing ties on a railroad, the manage-

ment might wish to have some further data to indicate just what the financial results would be when making the change from one kind of tie to another. In such a case, of course, the transaction with reference to each individual tie would be correctly covered by either the present worth or annual charge method, but the time required to "break even" on the excess expense involved for the more expensive tie would be greater than the length of time required to "break even" on one individual tie, for the reason that the excess expense for renewals in several succeeding years must be incurred before the results are obtained from the ties applied in any one year. The method of making the tie renewals, (that is, whether all renewals are made with the new kind of tie or whether only a percentage of renewals are so made) will also affect the time required in which to "break even." If a railroad company had all the money necessary to make improvements and take care of operating charges economically, this question of when the more expensive method would have paid for itself would be of less importance, but under existing conditions, with reference to railroads especially, it will be found in many cases that money can be expended in other improvements where it will bring much more rapid returns than would be the case in adopting a more economical kind of cross-tie.

As a matter of interest, it may be noted that in a case coming to the writer's notice a few years ago in connection with the claim made that a steel tie estimated to cost $2.10 would last 32 years, it was found that it would require somewhere near 75 years to "break even" on the excess cost of the steel ties (applying steel to the extent of 1-32 of all ties in track each year and the balance in wooden ties), this being on the basis that part of the wooden tie renewals would be with creosoted ties and part with untreated white oak ties, and on the assumption that there would be an increase of one per cent tie per year for the cost of wooden ties. There were other assumptions in regard to the use of tie plates, the proportion of treated and untreated ties used, etc., which made the problem complicated and this is mentioned only to bring out the fact that it required such a long time to "break even" on the excess investment. As a matter of policy, the writer believes that a railroad company would hardly be warranted in changing to a tie which would not individually prove an economy within 20 or 30 years at the outside, even if railroad money

were plentiful, as the increasing cost of timber and high cost of steel ties may result in the development of some more economical substitute in the future.

Mr. W. O. Pennell. (*By letter.*) In connection with Mr. Hendricks' comments on the example regarding the economy in erecting a new building or extending the existing building, I would like to give the following explanation: The new building would ordinarily be erected for a period greater than five years, and it was assumed in Plan No. 1 that if the present building is extended, at the end of the life of the extension, five years from now, a new building will be erected exactly similar to the new building in the other plan, Plan No. 2. Mention of this building with its annual charges was omitted from Plan No. 1, as the building would be finished at the end of the five-year period, and there would be no annual charges on it during this period. With this explanation I think it will be seen that the two courses do bring us out with comparable plants; namely, identical buildings.

I think Mr. Hendricks is correct in his statement that there has been a duplication of the item of depreciation. In calculating the transfer loss, the value of the building should have been depreciated by the amount of depreciation (1.25 per cent per year) for five years.

Mr. Hendricks states that he does not see any material advantage of present worth calculations as compared with annual charge calculations. Where the annual charges on the various courses under discussion extend over different periods of time and are of different amounts, it is difficult to compare one with another, unless they are all reduced to a comparable figure. The only way I know of reducing these annual charges to a comparable basis is by means of getting their present worth; for example, if one course involved an expense of $1,000 a year for five years, and another course involved an initial expense of $4,500 with no subsequent expenses, it would be difficult for the average man to determine which of the two arrangements gives the minimum expense, unless the present worth of the two courses are compared.

Mr. C. A. Hobein. (*By letter.*) I think the Club is to be congratulated upon the presentation of Mr. Pennell's paper. It exhibits careful preparation and should be a contribution very much valued by our members.

The discussion has brought out very many valuable uses to

which this process can be put. Mr. Pennell has brought out the value of the method in estimating the present worth of a leasehold.

I have found it very valuable in a similar way in calculating the value of a lease on a public utility operating plant by estimating the present worth of the future net earnings for the period of the lease.

[NOTE.—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

MODERN RAILROAD SIGNALLING.

By H. J. Pfeifer,*
Member of the Engineers' Club of St. Louis.

[Read before the Club, April 29, 1914.]

Signalling as applied to railroads is the art of conveying information as to the occupancy or condition of the track ahead to an engineman or conductor in charge of a train so that he may move his train, first, safely, and second, expeditiously. It is obviously necessary for the train crew to have this information whenever more than one train is operated over the line at the same time. The means of conveying it are numerous, and include the time card, dispatcher's orders, precedence of one class of train over another, hand or lamp signals, and fixed signals.

This paper will be confined to a discussion of fixed signals and the interlocking and other devices connected therewith.

The interest of the layman, I take it, in matters of this nature is rather in the results accomplished or hoped for than in a detailed analysis and description of the mechanisms by which they are secured. For this reason and the further, perhaps more important one, that the writer is not an expert technical signal engineer, and therefore hardly qualified to describe the world of electrical and other technical details involved in signalling, this paper will be strictly non-technical.

The end sought by all railroads, signal engineers, and the manufacturers of signal appliances is "Safety First." To be successful, however, in these times of dense traffic at high speeds, increased expense and low rates, a signal installation must have other qualities in addition, among which are facility, reliability, and economy.

In the early stages, attempts to secure safety and facility were more or less compromises between the two with sacrifices on the part of each. The advance of the art, however, has been so rapid of late years that less and less sacrifice is necessary. To secure safety and facility the signal mechanism must be reliable in operation, that is, subject to the minimum of failure.

*Engineer Maintenance of Way, Terminal Railroad Association of St. Louis.

True economy is not confined to the cost of installation, or even of maintenance and operation, but takes into account the entire conduct of the railroad and that system is the best in each case, which results in the safe movement of the traffic at the least gross expense, and in the shortest time, even though the signalling system is elaborate and costly in itself.

Fixed signals may be divided into two general classes, block and interlocking.

Block Signals.

The first are for the purpose of maintaining a proper space interval between trains on a given stretch of track, and the second for controlling the movement of trains at crossings, junctions and terminal points.

Probably the simplest form of block signal is the train order board or simple manual block at a station which is under the control of an operator or agent. Information as to the condition of the line is transmitted to him by telegraph, and in recent years by the telephone. Ordinarily this board gives three indications, "Stop," "Proceed cautiously" because of train in block moving in same direction, (this order is usually given to freight trains only) and "Proceed," block is clear. The manipulation of the signal is entirely in the control of the operator, there being no connection between adjoining stations, except for the transmission of information. You will note that in the use of this system, collision or accident may result, through the unchecked action of at least three men or agencies: First, the operator at the station in advance, having overlooked the train in the block, may give false information; Second, the operator may make a mistake and gave a clear signal with a train in the block ahead, and third, the engineman may fail to obey a stop signal.

The danger of this lack of control over the operators resulted in the development of the controlled manual block. In this system the signal is locked in the stop position and cannot be cleared until released by the operator at the station in advance. After the passage of the train the signal automatically returns to the stop position. This system increases safety because a clear signal cannot be given, except by the concurrent action of two operators. There is nothing about it, however, reducing

the danger resulting from the failure of the engineman to obey a stop signal.

An additional safeguard on single track lines is the electric train staff. In this system there are interlocked receptacles at each station containing staffs for delivery to the engineman. Not more than one staff can be taken out at one time, which is an assurance that there can be only one train in the block, as no train is permitted to enter unless the engineman has a staff. The staff is placed in a frame, adjacent to the track, similar to a mail catcher, out of which the engineman can take it if moving at a reasonably low rate of speed. As the train passes the advance block the staff is thrown off by the engineman and placed in its receptacle by the operator, after which it is again possible to withdraw a staff at either one end or the other. In addition to the main staff, provision is made for permissive staffs, which can be issued to following trains, and grant the right to enter the block under control and with the advice that block is already occupied. This gives great additional safety, because the key for unlocking the system is on the train itself and cannot be used until the train has cleared at either end. You will note that in this system also there is no mechanical device to check the engineman in case he fails to obey the signal.

The St. Louis tunnel is operated on an absolute controlled block, with a modified staff system added for eastbound freight trains only. On account of the smoke and darkness it is essential that not more than one train is on each track at one time.

The system consists of an interlocking machine at the west end of the tunnel, known as "X" office, and another at the east end known as "MS" office. They are a little more than a mile apart.

The two machines are connected by a system of electric locking which compels the co-operation of the operators at both ends before signals can be given which will permit a train to enter the tunnel. These signals, by means of track circuits, are automatically returned to the stop position behind the train accepting the proceed signal and entering the tunnel. The track circuit is in two sections of about 240 feet, one at each end of the tunnel. The signal automatically restored to the stop position and the signal governing in the opposite direction cannot again be cleared until the train has passed out of the tunnel.

As an additional precaution there must be a red light on the rear end of each train. The operator at the outlet station must see this light and then record on his train sheet the hour and minute during which the train passed his station. There is a heavy grade eastward through the tunnel and it is possible that an eastbound freight train may break in two, and leave cars standing between the track circuits, without being noticed by either the engineman or the operator. As the forward part of the train would release the track circuit control, it is within the bounds of possibility for the operator to make a mistake, say that he saw the red light on the rear end of the train, when he actually did not, and release the tunnel entrance signal at the west end for another train. The disastrous possibilities of the resulting collision with the cars in the tunnel led to the adoption, a few years ago, of the following device:

Before entering the tunnel the rear switchman on every freight train, who is compelled under the rules to ride on the rear end of the last car, is given a numbered leather disk by the yardmaster. This number is communicated to the despatcher or operator at the west end of the tunnel. As the train passes "MS" office at the east end the rear switchman delivers this disk to the operator, who reports its number to the despatcher at "X" office. Unless the number reported by the yardmaster and operator agree, no train is permitted to enter the tunnel until it has been found clear by a light engine feeling its way through.

Another form of block signal is the automatic, which is defined as follows in the Signal Dictionary:

"A block signal, worked by electric or pneumatic agency, which is controlled by the passage of a train into, through and out of the block section to which the signal is connected. The entrance of a train sets the home signal at stop, and the clearing of the block section by the passage of the train out of it sets that signal clear. The apparatus is so arranged that the misplacement of a switch or the accidental entrance of a car from a side track will set the signal at stop."

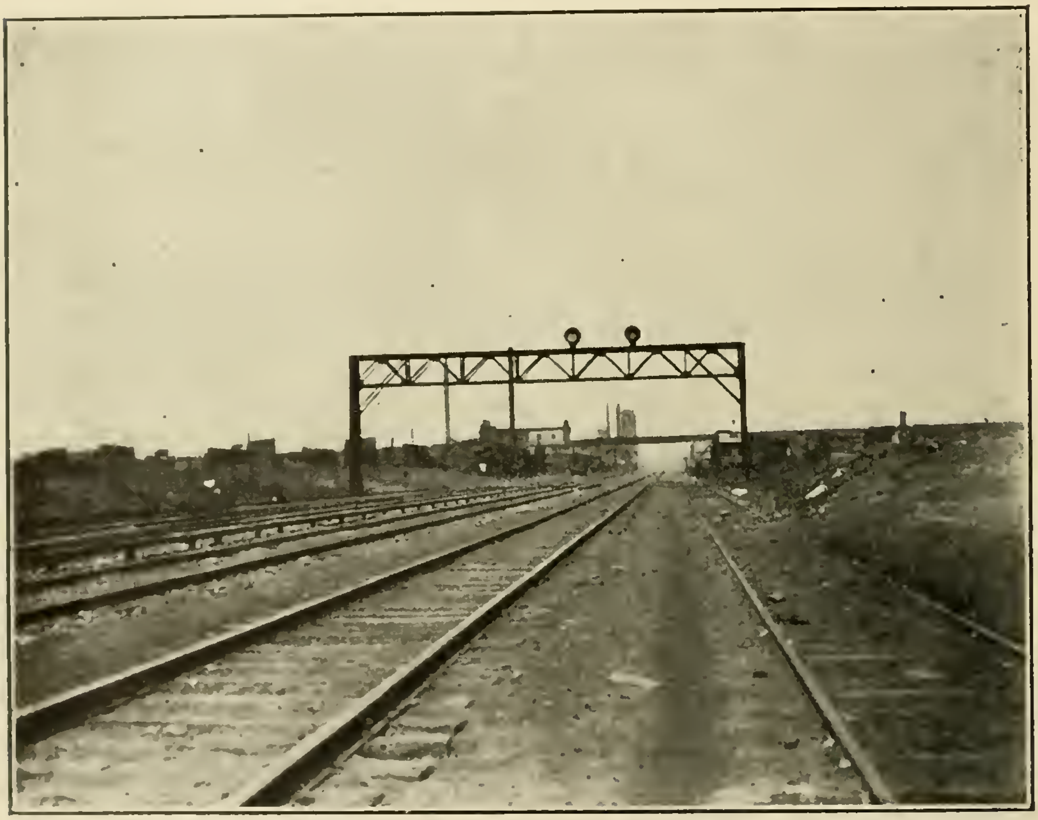
This result is accomplished by the use of the track circuit defined as follows in the same volume:

"An electric current flowing through the rails of a railroad track. In a typical track circuit, the current flows from the battery to the nearest rail of the track, thence to the other end of the track circuit section; thence by wire to the track relay

(controlling a signal) back by a wire to the farther rail, and by that rail back to the battery. Each rail is made electrically continuous from one end of the track-circuit section to the other by metallic bonds at the joints, and at the ends of the section insulated joints are used."

Automatic signals have been in use in this country since 1871 with "Track Instruments" and since 1879 with "Track Circuits."

The first form of Automatic Signal was the enclosed disk or



Automatic Block Signals. Banjo Type.

banjo type which is still used on some of the largest railroads. The day indications are given by the color or position of circular disks, and the night indications by the usual colored lenses.

Of late years the disk signal has been almost entirely superseded by the semaphore; defined as follows:

"A type of signal introduced on railroads in England about 1841 and now in almost universal use for both block and interlocking signals. It consists of an arm about 4 ft. long and 10 in. wide, mounted on a post usually 24 ft. to 30 ft. high at one

side of the tracks; or on a shorter post supported by a bridge or other structure above the track. Day indications are given by the position of the arm horizontal, inclined or vertical, and night indications by a light. The pivot of the arm is combined with a spectacle casting holding colored glass disks, which, as the position of the arm is changed, move in front of a lamp mounted on the post."

By far the largest portion of all automatic semaphore block signals are electric, although there are some electro-pneumatic, and electro-gas signals.

In some of the earlier automatic installations, the signal indicated the condition of the track for one block section only. It was found particularly in mountainous regions, where the view of the track ahead is obscured, that this was not sufficient, if a reasonable speed was to be maintained. Three general methods have been used to supply the engineman with additional information.

First, by the overlap, which is an extension of the track circuit one or two thousand feet beyond the advance signal. The effect of this is to encourage an engineman to pass a signal at danger, by giving him the assurance that the track for a considerable distance beyond it is clear. As there is a large element of danger in this, the use of the overlap as outlined is not considered good practice.

Second, by the use of the distant signal which, when clear, indicates that the home or main signal is clear, and when blocked tells the engineman that he must be prepared to stop at the home signal. The distant signal is frequently placed on the same mast with the preceding home signal, and by this means the condition of the track for the two blocks ahead is indicated.

Third, by the use of the three position signal, which indicates the condition of the track for two blocks ahead as follows:

Blade horizontal, first block occupied.

Blade inclined at an angle of forty-five degrees, first block clear, second block occupied.

Blade vertical, both blocks clear.

Automatic block signals are usually operated on the permissive system as follows: If a signal is in the stop position, the train must come to a full stop for one minute, after which it may enter the block under control prepared to stop in case of danger without any additional signal or warning.

The number and location of automatic block signals varies with the nature of the service. On lines of heavy traffic they must be placed as close together as possible, so as to get the maximum operating capacity out of the line. In no event should they be placed any closer than the distance required by the fastest and heaviest train to come to a full stop.

The automatic block signal is superior as a safety device to any of the manual block systems, because in addition to making known the presence of a train in the block, it also gives an indication of track obstructions, such as cars on sidings fouling the main line, broken rails or other defects destroying the continuity of the track.

The automatic block, like the manual, does not and cannot guard against the failure of the engineman to obey signals. The only manner in which the engineman can be controlled is by some system of automatic speed control or train stop, which would shut off the steam supply and set the brakes on the locomotive. There has been considerable talk about these devices but so far nothing practical for general use has been developed, and we must therefore depend on the care and watchfulness of the man at the throttle. After all, in spite of the multiplicity of automatic devices, we must always in the last analysis depend on a man or men for our safety.

One of the latest developments in automatic block signals is the use of alternating current signals. An installation of this kind was recently completed on the Southern Railroad between Denim, N. C., and Charlotte, N. C., a stretch of 100 miles. The line had been previously operated under the manual block system with 19 stations. When the new system was installed 15 of the 19 operators were no longer needed and were sent to other parts of the line. The power-house was installed at about the middle of the system and the current, which was also used for lighting stations and other buildings along the right-of-way, was transmitted at 4,400 volts. There are 118 signals in the system and the total energy required for the signals, track circuits and lights in the signals, is less than 10 kw.

There are at present more than 35,000 miles of automatic block signals in use on American railroads, and the mileage is rapidly increasing. Their installation in many instances is an economy, because aside from the greater safety secured they increase the traffic carrying capacity of the line to such an extent

that the construction of an additional track, entailing a much larger expense may frequently be indefinitely postponed.

Interlocking.

Interlocking, a short name for interlocking plant, has been defined as "An arrangement of switch, lock and signal appliances so interconnected that their movements must succeed each other

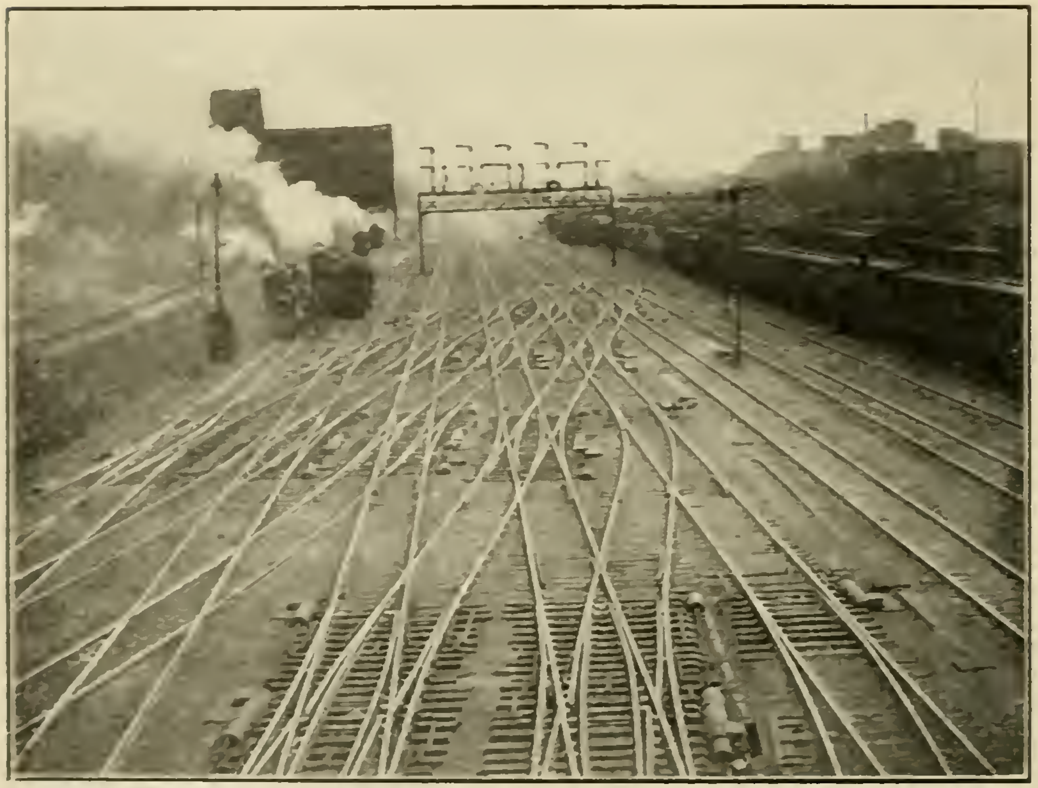
Automatic Block Signals, Upper Quadrant, Alternative Current, Semaphore Type. North Carolina.

in a predetermined order." The term includes the cabin, the machine, switches and signals and all the connections and appurtenances.

Patents for manually operated interlocking devices were first granted in England in the year 1856, and in 1873 the system had been so generally adopted in England that the London

& Northwestern Railway alone employed 13.000 interlocking levers. The first experimental interlocking installation was made in this country at Spuyter Duyvil Junction, New York City, in 1874. The first important installation on a commercial basis was made by the Manhattan Elevated lines in New York City in 1877-78.

Interlocking resulted from the desire on the part of English railways to save labor by concentrating in a single frame the levers operating a number of widely separated switches and signals. After this it was a short and simple step to so lock



Part of Electro-Pneumatic Interlocking Plant, Union Station, St. Louis.

these levers one with the other that a clear signal could not be given unless the route was properly set up, and so that signals for conflicting movements could not be given. As the cost of labor is higher in the United States than in England there was a demand in this country for an interlocking that would permit of the operation of switches and signals over greater distances and with fewer operators. This resulted in the development of a hydro-pneumatic interlocking, which was first installed in 1884 at Bound Brook, N. J., at the crossing of the Philadelphia & Reading and Lehigh Valley Railroads. From 1884 to 1891 eigh-

teen of these plants, having 482 levers, were installed on six railways. As the system developed many serious defects were found, and its inventors devised the electro-pneumatic system in 1891, which is still in general use, particularly in large installations.

The first interlocking in the St. Louis territory was installed in 1883-84 to control switches and signals at both ends of the tunnel, and at about the same time the crossings, switches and signals at the east end of the east approach to the Eads bridge were also interlocked. The levers of these machines were made to operate special valves which controlled the hydraulic pressure used to operate the switches and signals. Pipes were laid from the ports of the valves to the switch and signal operating mechanism in which the pressure was maintained by a system of pumps and accumulators or hydraulic rams.

It is here noted that this was one of the first interlocking plants using other than manual power installed in this or any other country. This type of machine, although it developed many defects, was continued in service with some modifications until 1899, when the present electro-pneumatic plant was installed at the tunnel entrances.

Interlocking development has easily kept pace with that in other fields.

The principal types of machines now in use in this country are the mechanical, the electro-pneumatic, the pneumatic and the all electric.

Mechanical.

A mechanical interlocking plant consists of a frame of levers in a tower, which are connected by means of pipe and wire-runs to switches and signals which are moved by manual power applied to the levers in the tower. Where the distances are not too great, the switch layout comparatively simple and traffic light, this type of plant is both cheap and efficient. With the present tendency toward the control of trains by the block system, most modern mechanical plants are equipped with a number of electrical safeguards, such as power distant signals, track circuits, electric route locking, etc. These trimmings in some instances have cost more than the mechanical interlocking itself.

Electro-Pneumatic.

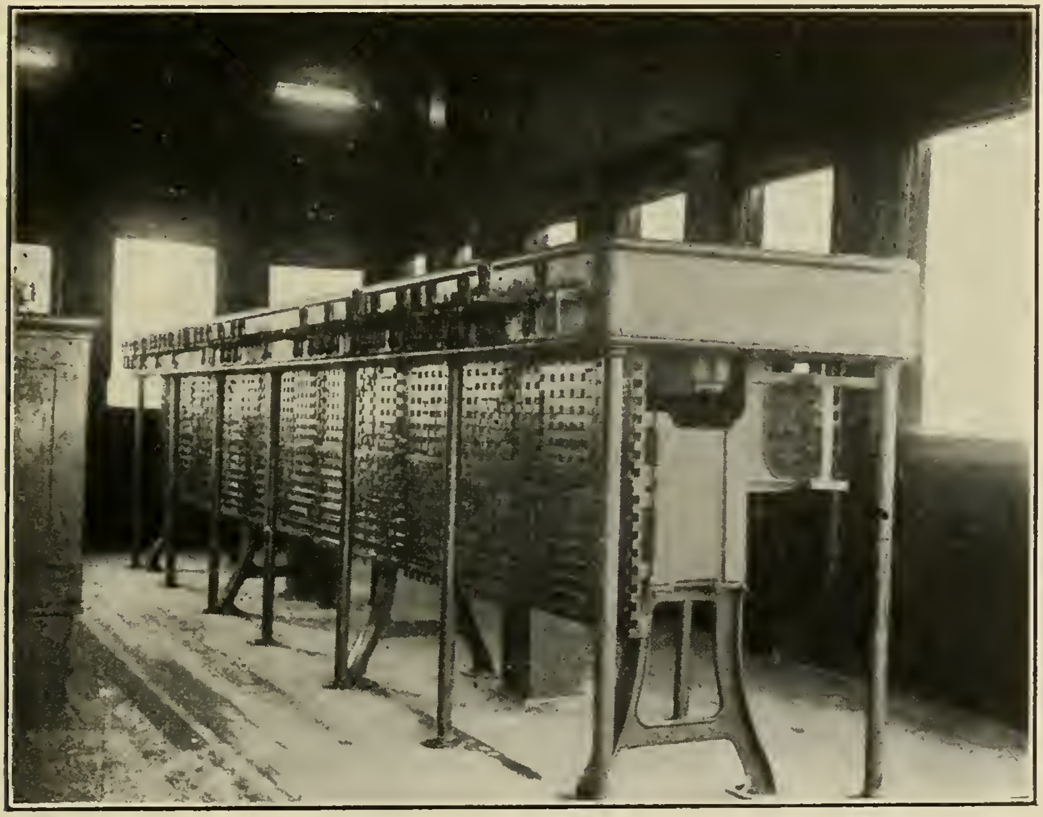
Electro-pneumatic interlocking was first placed on the market in 1891 by the Union Switch and Signal Company. It was found to be particularly advantageous for use in large, complicated installations. The original St. Louis Union Station interlocker built in 1891-92, was one of the first large installations of this system. This was followed a year or two later by the South Boston station interlocker, and since that time the system has been installed in some of the largest plants in the country, including the St. Louis Union Station as remodeled in 1903-1904.

Electro-pneumatic interlocking is described as follows: Compressed air at a pressure of about 85 lbs. is stored in a reservoir at or near the signal tower and is conveyed in pipe laid underground to cylinders, one at each switch and signal, in which the pressure by means of a piston, moves the switch or signal. The admission of air to a cylinder is controlled by an electric magnet fixed at its side, and the circuit of this magnet is controlled by a miniature lever in the cabin, the wires being run from the switch or signal to the cabin. These little levers are suitably interlocked the same as the large levers in a manual machine. The movement of a lever to work a switch does not, however, actuate the interlocking which releases the lever to be moved next; for the lever movement does not insure that the switch has actually been moved, it only closes the circuit. The next lever is held locked until by an electric current, the circuit of which is closed by the switch rails themselves, after their movement is completed, the "indication" of such completion is sent back to the cabin permitting the unlocking of the next lever.

Electro-pneumatic, in common with other forms of power interlocking, has many advantages over mechanical or manual, particularly in large complicated installations in which the installation of manual interlocking is practically impossible on account of the size of machine required and the great number of pipe-runs. The same amount of interlocking can be accomplished by power with fewer levers and each lever occupies about one-third as much space in the machine. A manually operated machine to operate the Union Station layout, if it were possible to properly lock it, would be at least two hundred feet long; and the pipe-runs would be so numerous and bulky that it would be difficult, if not impossible, to find space for them and the tracks too.

Pneumatic.

Another form of machine is the pneumatic or low pressure air which has been used to a limited extent within the past 12 or 14 years. This machine acts more slowly than the electro-pneumatic or all electric. In this system the pressure in the cylinders moving switches and signals is 15 lbs. and in the small pipes leading to the diaphragm valves it is only 7 lbs. per sq. inch. The signalman's work consists in opening and closing these valves. The interlocking is the same as in other machines.



Interlocking Machine. All-Electric Type.

All Electric.

The all electric interlocking was developed by J. D. Taylor about 1900. A switch is moved by a one horse-power electric motor fixed to the ties and worked by an electric current conveyed by wires from a dynamo or storage battery in the cabin; and a signal by a motor of 1-6 horse power, fixed to the signal post. The storage battery is usually charged by a generator run by a gasoline engine; and the amount of electric power used is so small that a small engine need be run but a few hours daily.

The machine in the cabin consists of a frame supporting horizontal sliding bars or levers, each movement closing a circuit to a switch or signal. The levers are interlocked as in other machines, and as in other power machines the interlocking is controlled by an indication sent to the machine from a switch after it has actually completed its movement. This "indication" current is generated by the momentum of the switch motor, which is converted into a generator for a fraction of a second after it has completed its work of moving the switch. The movement of a switch requires a current of only seven amperes.

All electric interlocking has been manufactured since its development by the General Railway Signal Company.

Among the large all-electric installations may be mentioned the new Grand Central Terminal at New York, and the Chicago & Northwestern Terminal at Chicago. The latter is one of the most recent and up-to-date installations, so that a short description of it may be interesting. The Lake street or main plant controls the entrance to 16 station tracks, which converge into six main lines. The semaphore signals are all of the three-position upper quadrant types and the dwarf signals are also three-position. The signal blades when horizontal mean stop; when inclined at an angle of 45 degrees, proceed, stop at next signal; and when vertical, proceed.

In place of mechanical detector bars, which are usually istalled at all interlocked switches to prevent the throwing of the switch under a train, electric track circuit locking is substituted. Miniature lights are placed on switch levers to indicate the presence or absence of trains on the switches and illuminated track diagrams are employed to give information to levermen as to occupied or unoccupied condition of all tracks.

An elaborate system of route and release locking is installed at this point, which by means of track circuits, controlling lever locks in the interlocking machine, prevent the movement of switches in a given route after a clear signal has been given to and accepted by a train over such route, even though the governing signal has been restored to normal or stop position. An ingenious feature of this "Route and Release" locking system is that while it is impossible to change the position of switches ahead of a train moving over the route, it is possible to move switches immediately after it has passed, thus permitting a new route to be lined up for a following train. In the older methods

of track circuit route locking the train must pass over all the switches in the circuit before any of them can be moved. The former scheme greatly faciltates train movement, while retaining all of the safety features of the latter.

All electric interlocking is now being manufactured by the Union Switch & Signal Company, and other companies, as well as by the General Railway Signal Company.

There has been in late years a good deal of discussion as to the proper signal aspects for both day and night. While practice is not uniform the consensus of opinion is that a semaphore signal at the right side of the track or above it, with the semaphore blade to the right of the mast and working through the upper quadrant is the best practice. In this type of signal the blade horizontal means, stop; inclined upward at an angle of 45 degrees, proceed cautiously; and inclined upward at an angle of 90 degrees, proceed. At night the stop signal is a red light, the caution a yellow and the proceed a green light. Formerly, a white light or an ordinary flame seen through an uncolored lens was the clear indication, but on account of the danger of confusing this light with others in the vicinity, and the fact that the breaking of a red lens might cause a light to appear white when it should be red, the green light was adopted for the clear indication.

At interlocked railroad crossings it is the general practice, and in most States the law requires the installation of derails and distant signals. The derail on high speed tracks is placed about 500 feet from the crossing and will throw a train off the track if the stop signal is not obeyed by the engineman.

The distant signal is placed about 2,000 feet ahead of the derail and warns the engineman that he is approaching an interlocking plant. The distant signal gives two indications; one that the home signal is clear and that he may proceed over the crossing without stopping, and the other that he must approach the home signal prepared to stop.

It is customary in modern installations to have a track circuit route locking which will prevent the moving of any switch or signal on the route after a train has accepted and passed a clear distant signal and until it has passed the home signal or through the entire plant.

The Federal government has not as yet undertaken to control the installation and maintenance of interlocking and block signals, although a bill was introduced in Congress on September 10, 1913, by Congressman Esch headed as follows:

"To promote the safety of employees and travelers on railroads by requiring the use of automatic block systems and automatic train control devices by common carriers engaged in interstate commerce."

What its chances for passage are I do not know, but it seems somewhat premature, particularly so far as automatic train control is concerned at the present time.

Quite a number of States have laws regulating block systems and interlocking.

Illinois through its Railroad & Warehouse Commission (now State Public Utilities Commission) has for a number of years enforced a stringent but fair and reasonable regulation and inspection governing interlocking plants at railroad crossings.

A little over a year ago the engineers of the commissions of Illinois, Indiana, Wisconsin and Minnesota invited representatives of the railroads operating in those States to meet with them for the purpose of discussing interlocking rules and report forms. After a number of meetings uniform rules and report forms satisfactory to the railroads were adopted in all of these States, and they have since been adopted without modification in Missouri and Iowa.

I wish to acknowledge my indebtedness to Mr. Morris Wuerpel, Jr., formerly Signal Engineer of the Terminal Railroad Association of St. Louis, and now Assistant General Manager of the General Railway Signal Company, and to Mr. Aaron Dean, Western Representative Union Switch and Signal Co., for a lot of valuable information, and to Mr. George B. Ross, Electrical Engineer of the Terminal Railroad Association of St. Louis, for preparing the photographs and slides which will now be shown.

DISCUSSION.

Mr. A. P. Greensfelder. Mr. Ross, do you know the number of trains that enter and leave the Union Station at any period? I know it is amazing. I used to spend two or three nights in the tower when I was in the vicinity of the Union Station. It is one of the most interesting things I know, to see the possible number of train movements and variety of signals and routes

which it is possible to give through an interlocking plant of that size. Do you know the number of levers in the Union Station tower?

Mr. G. B. Ross. Two hundred and fifteen.

Mr. A. P. Greensfelder. Do you know the number of possible routes?

Mr. G. B. Ross. I do not remember that.

Mr. A. P. Greensfelder. Through those 215 levers, I think there are 1,000 possible routes.

Mr. E. A. Chenery. Mr. Pfeifer's paper was particularly interesting to me owing to my former connection with the Terminal Association. When I entered the service of that company in 1887 there were only three interlocking plants on the property, one located at each end of the tunnel and the other at the Relay crossing, East St. Louis. Since that date a number of additions have been made, until to-day the Terminal Association not only has in service the latest type of signalling apparatus but some of the largest installations to be found in the country.

When I came to the Missouri Pacific in 1903 and was placed in charge of the telegraph department, my duties also included the direct supervision of all signal installations and maintenance. At that time we had but a few interlocking plants of the mechanical type, a few crossing bells at street crossings and no automatic signals whatever. With the march of progress our company very shortly thereafter began the installation of its first one hundred miles of automatic signals in the vicinity of St. Louis and developments soon called for additional electric signals at dangerous road crossing, new interlocking facilities at various railroad intersections and other necessary signal facilities and protection. A separate department was then created for the handling of such important work.

Much progress has been made in the art of signalling during the past few years and experts are exercising their energy to further perfect the system. National and State legislatures and commissions are also giving this matter much thought in an effort to prevent personal injury and property loss and a continued improvement along this line will surely result.

Mr. G. M. Curry. I should like to hear Mr. Pfeifer say a few words about how they handle snow in the Terminal yards.

Mr. H. J. Pfeifer. When it begins to snow the track forces

begin salting the switches. Nothing else is done until the snow becomes so heavy that the salt alone will no longer melt it. The switches are then swept out with brooms, the use of the salt being continued. When the snow becomes so heavy that brooms will not suffice, shovels are used in addition to the brooms. During extremely heavy snowstorms a hydrocarbon oil, which is a by-product resulting from the manufacture of Pintsch gas, and which is very volatile, is poured on the snow at the switches and ignited, resulting in the melting of the snow.

At the St. Louis Union Station we have had great success in keeping traffic moving during snowstorms by the use of this oil.

The principal thing is to maintain a good snow fighting organization. All of our trackmen and the forces in the Bridge and Building Department, as well as interlocking repairmen have stations assigned to them during snowstorms, and things are so arranged that each man knows as nearly as possible what is expected of him before the storm begins. During heavy storms the regular forces are, of course, supplemented by extra men hired for the occasion. All of the forces engaged during snowstorms are kept on duty continuously, their meals being served to them on the property or in boarding houses adjacent thereto.

Mr. L. Gutman. I was very much interested in Mr. Pfeifer's paper, but there seems to be one point which is not clear to me. He states that owing to the high cost of labor, a great deal of machinery was introduced in signal work and toward inducing safety. While that is so, it is rather surprising to me to see that on crossings men are always used in this country, while abroad practically 95 per cent of the railroad crossings are without manual labor. They have no bars laid across the street, but there is a gong that operates for 15 minutes before the train approaches. I should like to know why these automatic gongs are not more in use in this country. They are inexpensive, and I cannot understand why the man at the crossing uses a flag, and why the wooden gate is so much more used than the gong.

Mr. H. J. Pfeifer. We have a few automatic crossing alarm bells in outlying sections. If we had them at street crossings in the city where there is a lot of switching, they would be ringing all the time. For the average city crossings, a crossing gate operated by a watchman is, in my opinion, safer than an automatic

crossing alarm. Railroads do not, as a rule, maintain crossing watchmen, except in cities.

Mr. W. H. Davis. There was one point which interested me particularly, and that was track circuits in side tracks. In the last few years I have heard of a number of instances where an engine on a side track would drop sand on the rail, which prevented electric contact so the engine could go out beyond the fouling point, without shunting signal to danger, and cause side-swipes. This is also true in sandy countries, and as a preventive derails are installed to supplement the fouling circuit.

There are some other incidents which came up in Louisiana in the cane districts. During the cane season they would have a great many signal failures and fast trains would be stopped. On investigation they found that the cane loaders would pinch the cars out just beyond the insulated joint, shunting signal to danger, although the cars would not go out far enough to foul the main line. To prevent these delays to train service, derails were installed back of the fouling circuit.

In connection with interlocking plants, I think about the most striking way for the average layman to realize the importance of this work is to get on a motor car and go through some complicated plant. I remember the first time I went through such a plant. Although there were engines all around us, we felt perfectly secure because we were lined up.

Mr. J. W. Woermann. I am one of the laymen referred to, so I cannot speak on the technical features, but, in making a hasty inspection of the new Grand Central Station in New York, I was greatly impressed with the great advancement that has been made in this science. The feature that impressed me most was a diagram, not much larger than a table, on which the entire layout of the tracks were duplicated, on a small scale, and a great number of tiny lights underneath, so that the man sitting there, the main operator, perhaps he was called, could tell by those lights going on and off just how the trains and engines in the yard were moving. I thought that was very ingenious.

Mr. A. P. Greensfelder. Did you notice whether the operators were looking at that? If I am not mistaken, they take a particular pride in knowing all the movements and possibilities without looking at the indicators. I remember very distinctly when the question came up of installing what was called an in-

dication board, or something of that kind, in the Union Station tower. All the operators objected to having it put in. They felt it was hurting their standing as operators that they should need such a reminder. But it was put in anyway, as a reminder, and they thought the old operators might look at it when the boss was not around.

Mr. S. D. Webster. I did not come here loaded, but one cannot hear an interesting paper of this kind without having his mind taken back to times when there were no light signals. The first signal device I recall as a kid was a rope on a reel on the back end of the tank, and that rope was uncoiled and run clear back and made fast at the end of the train. If that train broke, the rope told the story. That was kept up for years. However, the light is the essential feature. I remember when the attempt was first made to get a uniform code lantern signals for trains. I remember, too, that the proposed signal for "back up" was an up-and-down motion with a light. The attention of the American Railway Association was called to the fact that the motion which a man used when he wanted to put out his light was to jerk it up and down, and if the men used that motion for the back up, and the light went out, the engineer would have nothing to go by, but if used for "go ahead," the engineer would look out for his own end. They changed the rule and made the up-and-down motion the "go ahead" signal which it has since remained.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

THE DEVELOPMENT OF A UNIT COST SYSTEM

Discussion by Julius M. Bischoff,
Member of the Engineers' Club of St. Louis.

(Volume 53, page 74, August, 1914.)

Having had charge of a considerable amount of construction work, some of which was carried out by contract and some by administration forces, I was very much interested in reading Mr. Nelson Cunliff's paper entitled, "The Development of a Unit Cost System," and the consequent discussion aroused.

My experience forcibly brings to mind that the value of cost data depends on:

(1) Under what conditions such cost records were obtained.

(2) The use to which such cost data is to be put.

The conditions governing the work at the time of obtaining cost records is a very important factor and determines their value for future use. If obtained on a big job where a large properly organized force has been used and where proper machinery and labor saving devices could be used, such unit costs evidently cannot be applied to smaller jobs where the unit cost would be higher for the same class of work.

Broadly speaking, the conditions governing the work can be divided into three classes, viz.: favorable, ordinary and adverse. These classes are largely determined by weather conditions and by the delivery of material. As Mr. Greensfelder very pertinently remarks: "So in fabricated material we have gotten beyond that point where we let it to the lowest bidder. We let it to the man who can give us service." It makes quite a difference when material is delivered. I will cite an instance in laying track for a railroad. Consider that you have a 25 kilometer extension on which you are to surface and lay track. Under very favorable conditions (I may say this is a condition for which we strive but never attain) the ties, rails, angle bars, spikes and bolts are delivered to the extension on flat cars in such quantities and at such times that there is always enough on hand, thereby being able to send the loaded cars out to the end of the track and used direct from the flat cars on which the material arrived, instead of first unloading into stock piles. Stop a moment and consider the saving and hence the reduction in unit costs that would re-

sult as compared with the ordinary conditions where material arrives in large quantities; work stopped to unload into stock piles in order to release the cars and avoid congestion of tracks; then reload from the stock piles for a day's run.

Then take a case under adverse conditions, as for instance when the railroad company is furnishing rails and the contractor is laying track at a price per kilometer. The contractor is furnished a portion of the rails. He organizes his forces and proceeds to lay track. The railroad company, however, does not have a sufficient number of rails on hand to complete the work, but has contracted with a large company for delivery of rails on a date which is at least two weeks before the date that the contractor can lay the rails on hand. The company furnishing the rails fails to make delivery as agreed. The contractor is forced to disband his gang. Then the rails arrive in a boat and must be unloaded at once owing to the high demurrage charges. Only a limited number of cars are available for transporting the rails and these cars must be unloaded at once and rushed back to the wharf and reloaded. The unloading of the cars on the extension must be done by the contractor under his contract as this is included in his price for surfacing and laying track. The contractor must organize a gang to unload the rails as he has left his tract laying gang go. Then it is discovered that the rail company, a reputable one, has neglected to ship the angle bars even though they had advised that the rails and angle bars had been shipped. The contractor is again forced to wait until another boat arrives with the remainder of the rail shipment and the entire shipment of angle bars. But inexplicable as it may seem, the angle bars are in the bottom of the hold underneath the second shipment of rails. You may say that the company making the rail shipment was a poor company; on the contrary, it is rated one of the best. The contractor now must organize and break in a new track laying gang.

Now, having the unit cost of laying rail under these three conditions, which shall we use? Obviously neither the favorable nor the adverse condition can be used. Hence, we must use the costs obtained under ordinary conditions.

To my mind these three conditions represent the experience of contractors who are bidding on work. The low bidder is the contractor who has done a similar piece of work under exception-

ally favorable conditions and thinks he will repeat. The high bidder is the one whose experience has been under adverse conditions, and the intermediate bidder's experience has been under conditions varying between the two extremes.

The engineer, if he has had a broad experience, will base his estimate on ordinary conditions, and therefore his estimate will more nearly be a mean between the high and low bidders as cited in the example by Mr. Rolfe.

In laying track with the same organization, I find that the unit cost varies greatly, work under adverse conditions costing in some instances twice as much as under favorable circumstances.

Another item that varies greatly is overhead charges. Suppose there are seven jobs going on simultaneously and five are finished, some time before the other two, after which the remaining two jobs must take the overhead charges. The proportion will not be two-sevenths but more nearly five-sevenths. Hence the work on the first five jobs, if all are done under the same conditions, will apparently have been done at lower unit costs.

Engineers in making estimates should use liberal unit costs and not those obtained under favorable conditions. In fact, the unit costs used should be higher than those obtained under ordinary conditions. It is probably a non-observance of this suggestion that causes bids to be refused because of an inadequate appropriation for the proposed work.

In comparing unit costs obtained by administration forces with contract prices great care should be exercised so that all conditions to which a contractor is subject should be allowed for.

It is a lamentable fact that unit costs are often given, and used, which really represent only the actual labor cost. No provision is made for such items as overhead charges, equipment, tools, insurance liability, interest on money, wear and depreciation, cost of making and presenting bids, etc. Furthermore, the contractor must rent an office, whereas the man in charge of administration work is furnished an office. This is an item generally lost sight of.

Discussing the use to which cost data is to be put we have, broadly speaking, three uses, as follows:

(a) In making estimates for future work.

(b) In making bids for proposed work.

(c) In judging gang performance on work in progress.

Unit costs in making estimates should be liberal for reasons outlined above and should be high rather than low so that ample funds will be appropriated for the proposed work.

The contractor, in bidding, should use unit costs obtained under ordinary conditions, and hence these will be slightly lower than those used by the engineer in making his estimate.

Unit costs for judging gang performance should be those obtained under favorable conditions. Then the superintendent, or chief construction engineer, can make allowances for conditions affecting the particular job under consideration, and thereby determine whether the work is being done as economically as possible under the actual governing conditions.

The foregoing, I believe, brings out the fact that unit costs without cost analysis are of very little real use.

Daily cost data records should embrace the following information:

(1) Location of the work.

(2) Date.

(3) Weather conditions during the day and of the night before.

(4) Hour of beginning and stopping work, also number of hours worked.

(5) Classification of work and hours on each class.

(6) Rate of pay and amount of each class of work.

(7) Total hours and total wages.

(8) Remarks, under which adverse conditions are noted.

(9) Amount of material used, received, and on hand.

(10) Amount of each class of work done during the day.

Where possible, printed forms are preferable. For instance, in steam shovel work, where the duties of the crew do not vary. Also in running work trains, where daily train sheets keep the superintendent informed as to the length and causes of delay. The economical operation of the steam shovel being dependent on the car service. However, for pile driving, concrete, bridge carpenter, station and miscellaneous buildings carpenter, track laying and surfacing gangs, it is best to have the timekeeper, or

inspector, makes his own classifications and then make the desired changes and classifications in the office.

I find that too much detail is generally attempted in keeping cost data. It is well to limit the subdivisions as much as possible. As Mr. Woermann points out, a certain subdivision of cost units may be ideal for one class of contractors and unsuitable for another class. The use to which the cost data is to be put must first be determined and then the cost units desired selected.

By the use of progress diagrams and daily labor reports a general idea of the cost can be obtained at a glance. If the progress work does not seem to be consistent with the expenses, the unit costs can be determined in a few minutes, as the cost engineer in the office can furnish the cost to date, or between certain dates; also the corresponding amount of work completed on the particular job under consideration. Then if the adverse conditions noted under the "remarks column" on the daily reports do not explain the unit cost, the cause should at once be investigated. Thus one need not wait until the end of the job to find out that the job has cost too much money, and the reason. Instead, proper steps can be taken to reduce the unit cost if possible.

The system used by me for obtaining cost data on railroad construction by administration forces was as follows: Each extension was in charge of an assistant engineer who was responsible to the chief construction engineer for all work on his extension. The assistant engineer was furnished with a head timekeeper, and such assistant timekeepers as were necessary. The head timekeeper made out all reports—a separate report for each gang. These reports were O. K'd. by the assistant engineer and sent into the general office where they were checked and summarized. The timekeepers spent their entire time on the work during the day taking notes which were reduced to a report form at night by the head timekeeper. As the assistant engineer acted in the capacity of superintendent he was familiar in a general way with the work done during the day. From the reports, a copy of which was kept on the work, and from his general observations during the day, the assistant engineer was in a position to see if the unit costs were about what they should be.

If not, he could determine the reason and take up the matter with the foreman the next morning.

These reports were mailed to the general office each day and after being checked were scrutinized by the chief construction engineer who would take up with the assistant engineer any costs which were deemed too high.

By this system constant check was kept on the cost of the work and any adverse conditions which occurred were investigated and remedied if possible. If unit costs were high on one extension, similar unit costs on another extension could be cited; thus an amicable rivalry could be maintained between the forces on the different extensions which resulted in reducing unit costs.

Each month a report was made of the progress and cost of the different classes of work in the different extensions.

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STEEL RAILS.

By CAPTAIN ROBERT W. HUNT.*

[Read before the Engineers' Club of St. Louis, May 20, 1914.]

Before taking up the consideration of steel rails and their manufacture, perhaps it will be well to briefly refer to the history of some of the earlier railways built in America.

The first railroad chartered in the United States was in 1815, and by the Legislature of the State of New Jersey, but it was never built.

In April, 1823, the New York Legislature granted a charter to the Delaware & Hudson Canal to construct a canal and railroad for the transportation of coal from the anthracite coal fields of Pennsylvania to the Hudson river. The road was 16 miles long, but was not completed until 1829. It was on this road that the first locomotive was run in America. On Saturday, August 8, 1829, the Stourbridge Lion, built in England, and weighing six tons, made its first trip, but its active life was short, as it was found to be too heavy for the superstructure of the road.

The first American built engine was operated on the Baltimore & Ohio Railroad in August, 1830. It was named "Tom

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Thumb;" Peter Cooper designed and constructed it. He was somewhat restricted as to materials, as he had to use gun barrels for boiler tubes. The whole machine weighed but one ton, and burned anthracite coal. The experiment was successful, and, based on it, later machines were designed and built, the first one of practical size and use being the "Best Friend of Charleston," which was constructed at the West Point Foundry in New York City for the Charleston & Hamburg Railroad of South Carolina. It went into active and successful use on that road in December, 1830.

Only some five years intervened between the opening of the first railroad in the world intended for general freight and passenger service, the Stockton & Darlington, September, 1825, and that of the first one in the United States for the same purposes, the Baltimore & Ohio Railroad; its construction was begun on July 4, 1828, and "cars were put upon it for the accommodation of the officers and to gratify the curious by a ride" in 1829, but it was not formally opened for travel until May 24, 1830. It was then 13 miles long, extending from the city of Baltimore to Ellicott's Mills, Maryland.

Thus in railroad building, as in many other things, the Americans were disposed to follow closely after their English relatives, and perhaps, like other younger people, were soon not satisfied to follow, but aspired to lead; thus, the next passenger railroad to be constructed was, in this country, the Charleston & Hamburg, already mentioned. This was opened for public use in December, 1830. In September, 1833, it was completed for a distance of 135 miles, and was "the longest continuous line of railroad in the world."

The nucleus from which later came the great New York Central & Hudson River Railroad System, was the Mohawk & Hudson Railroad, chartered by the New York Legislature in 1826, but not begun until 1830, and opened for travel in 1831. It extended from Albany to Schenectady, 17 miles.

There were some earlier railroads, or, more properly, tramways, built in the States, but those named were the first really commercial ones.

The rails used on these roads were made of wood with flat bar iron nailed to their upper surface. The track of the Baltimore & Ohio Railroad is described as consisting of "cedar crosspieces, and of string-pieces of yellow pine from 12 to 24

feet long, and six inches square, and slightly beveled at the top of the upper side for the flange of the wheels, which, at that time, was on the outside. On these string-pieces iron rails were placed and securely nailed down with wrought iron nails four inches long. After several miles of this description of road had been tried, long granite stabs were substituted for the cedar crosspieces and the yellow pine stringers."

"The iron used for rails was ½ to ⅝ in. thick by 2½ to 4½ in. wide. The heads of the nails or spikes holding it down were countersunk in it." I should judge from the varying thicknesses and widths that the specification for an inspection of the rails were not very rigid.

Notwithstanding these strap rails being "securely nailed down," it was found that traffic would loosen them, with the final result of their turning up as the wheels passed over them, forming what were called "snake heads." These would occasionally tear through the bottoms of the cars and cause more or less inconvenience if not danger to the passengers. So the American engineers again turned to England, where the same difficulties had led to the invention of rails of different sections. I believe the first one was the fish-bellied rail invented by John Birkinshaw of the Beddington Iron Works, and patented in October, 1820. This rail was held in cast iron chairs by side keys or wedges. The Baltimore & Ohio Co. soon imported some of these rails.

The Stockton & Darlington, and its follower, the Liverpool & Manchester, which was opened in September, 1830, were principally laid with rails of the Birkinshaw type. The Stockton & Darlington also had a few cast iron fish-bellied rails.

The Clarence rail was another English invention, and was considered an improvement on the Birkinshaw. Rails of that pattern were imported into America for the Allegheny Portage Railroad, built by the State of Pennsylvania over the Allegheny Mountains to connect the canals on either side of them. This road was opened in 1833.

In 1834, the Columbia & Philadelphia Railroad was opened. Part of this road was laid with flat rails, but on the greater part the Clarence was used. On both roads the rails rested on stone blocks. These roads were in after years absorbed by the Pennsylvania Railroad.

Another English section was the I rail, which rested in a

chair. These were imported and used on some of the roads. Still later came the U rail, known in Wales as the Evans patent, and I believe first rolled at the Dowlais Works.

Some of the flat strap rails were made in America, but all of the sectioned ones were imported. Some attempts were made with American cast iron rails, but with unsatisfactory results. It was not until 1844 that the manufacture of sectioned wrought iron rails was begun in America. A rolling mill was built in 1843 at Mount Savage, Allegheny County, Md., expressly to make rails. Operations commenced in 1844, and for their first rail, which was of the U section, a silver medal was awarded the Mount Savage Rolling Mill Co. by the Franklin Institute of Philadelphia. The rail weighed 42 pounds per yard. About 500 tons of them were laid in 1844 on the road then being built between Mount Savage and Cumberland, Maryland. They soon rolled some 52 pound rails for a road between Fall River and Boston. In 1845-46 this mill rolled T rails. This mill, after being long idle, was finally dismantled in 1875.

The T rail was first rolled in America in 1845, and was generally known in Europe as the "Vignoles" rail, after Charles V. Vignoles, an English railroad engineer, who introduced its use there; but it was really invented by Robert L. Stevens, of Hoboken, N. J., president and engineer of the Camden & Amboy Railroad. That T rail was the original section from which the later and present ones have developed. In 1845 the Montour Rolling Mill at Danville, Pa., was built expressly to roll T rails, and in October of that year there was rolled in that mill the first of that section made in America. In 1846 T rails were rolled by the Boston Iron Works, Boston, Mass. In 1846 Cooper & Hewitt's mill at Trenton, N. J., rolled T rails. During the same year T rails were rolled by the New England Iron Co., Providence, R. I., by the Phoenix Rolling Mill Co., Phoenixville, Pa., by the Great Western Iron Co., Brady's Bend, Pa., and by the Lackawanna Iron Works, Scranton, Pa.

In the following and immediately succeeding years, the manufacture was taken up by other concerns, but, owing to the then prevailing commercial conditions, through the severity of foreign competition, by early in 1850 only two out of the fifteen rail mills in this country were in operation.

These early rails were all of short lengths, none over 15 feet long. As the difficulties of manufacture were overcome, and the science of track laying progressed, the length was gradually increased until that of 21 feet was reached, and was considered the limit, and it was not until about 1859 that railways would accept them of greater length. The first rails rolled in America 30 feet long were made by the Cambria Iron Co., Johnstown, Pa., in 1855, but they could not find sale for them, and they were finally used by that Company in their mill yards. The first 30 foot rails rolled to fill an order were made by the Montour Co., at Danville, Pa., in January, 1859, for the Sunbury & Erie Railroad Co. That length remained the standard one until a few years ago, since when 33 feet has been the standard length.

The rolling of iron rails was attended with many difficulties. If the pile of bars was not heated to a sufficiently high degree, the welds would not be perfect; and, if heated too highly, the iron would crack in the process of rolling, and yield an imperfect product. If the character of the metal was too soft, while the rail might be free from flaws and bad welds, it would wear out rapidly under traffic. Under all circumstances, it was important that the rolling process should be completed as quickly as possible so that the reductions should be made while the iron had lost little of its heat. This, together with some local conditions, led to the invention by John Fritz of the three high rail train. Three high sets of rolls had been used for many years in making merchant bars, but it required the application of the "Fritz Yielding Hanging Guides and Driven Feed Rollers" to make them practical for rail rolling. This improvement was put into successful operation at the Cambria, Johnstown, Pa., mills in 1857. It has ever since remained as the typical American rail mill. Since the introduction of steel rails, there have been several two high reversing mills on the English plan used in America, in fact, two such are now running; but the three high is the American mill, and has made possible the tremendous production which has been attained in later years.

The early rail mills required the work of handling the material as it passed through the rolls to be done by manual labor through the use of tongs and hooks. Probably the roll-

ing of iron piles, with their necessary peculiar handling, would have indefinitely continued this, but, with the use of solid steel blooms, the troubles lessened and made possible the introduction of automatic machinery. The tong and hook system necessitated the employment of 15 to 17 men with a production of steel rails limited to not over 250 tons per turn of 12 hours. Automatic machinery revolutionized this, both as to number of men employed and possibilities of production.

It was my fortune to introduce the first driven rail mill tables; these in the works of the Albany & Rensselaer Iron & Steel Co., Troy, N. Y., in March, 1884. These were in front of the finishing rolls. They worked so well that I soon after put an automatic arrangement in front of the roughing rolls. This latter arrangement was more particularly designed by Mr. Max M. Suppes, then the master mechanic of the works, and now the general manager of the Lorain Steel Co., Lorain, Ohio. Naturally, we protected ourselves by letters patent. From this start we made other inventions, and many improvements have been made by other American engineers until the present American rail mill, capable of turning out an average of 50,000 to 60,000 tons of finished rails per month has been developed.

As I have described, the first iron rails were made from straight puddled bars. These bars were about one inch thick and six inches wide, and were placed one upon another, until a pile of sufficient weight and height was formed, then reheated and rolled into rails; and it was upon the formation of that pile that inventive genius was applied. From the investigation of the fracture of some of these rails which had given satisfaction, it was discovered that the pile of bars from which they had been rolled had been entered in the rolls edgewise, thus bringing the line of welds between the bars in the finished rail in a vertical instead of horizontal position. This presented a different structure to the wheel wear, and seemed to be logical. Based on that supposition, many rails were so rolled, and I believe the scheme was patented.

Where the rail was rolled with the layers of the pile in a horizontal position, particular attention was given to the character of the top bar—this would, of course, form the head and wearing surface of the rail. Cold-short or granular iron

was used for it, while the remainder or at least the flange of the rail was of fibrous iron.

At one time a rail with a puddled steel head,—or rather, with the top bar of the pile of puddled steel,—found much favor, but, owing to the difficulty of obtaining uniformly good welds, the results were not satisfactory. Some of these so-called steel headed rails had the top bar of what was known as silicon steel.

Then, as since, commercial conditions controlled. The railroads had the worn out rails on their hands, and so, regardless of whether or not the practice would give satisfactory results, generally adopted a system of having the old rails re-rolled into new ones. At first a certain percentage of new iron was specified, but, as the necessities for immediate economies increased, that demand was eliminated from the contracts, and the new rails were composed entirely of the old ones. The best practice was to make a pile of old rails, break it down into bars, which were piled upon each other, and then rolled into rails; but presently this was too expensive to successfully meet the cry for cheaper rails, and only the top and bottom of the piles were formed from re-worked iron; the center being composed of from three to six pieces of old rails.

From the many re-workings, the cheapening of the process of manufacture, and the increasing demands of the traffic over them, the wear of the iron rails became more and more unsatisfactory, until it seemed as though from that cause alone the limit of railway development had been reached. Such situations frequently occur in earthly affairs, and seldom, if ever, has the occasion failed to be met by a solution of its difficulties. In this case came the invention of Bessemer.

It is a historical fact that the first rail ever made from Bessemer steel was placed at a point on the Midland Railroad, of England, early in 1857, where iron rails had sometimes to be renewed within three months, and it remained there until June, 1873, some sixteen years, during which time about 1,250,000 trains and any number of detached engines and tendors passed over it.

Railway managers were timid about using steel rails, and in America many attempts were made to produce a satisfac-

tory rail having an iron base and web with a steel-capped top. None were satisfactory, and the Bessemer steel rail soon conquered the situation.

The first steel rails laid down by an American railroad were imported by President J. Edgar Thomson, of the Pennsylvania System. The first to be manufactured in America were rolled at the mills of the North Chicago Rolling Mill Co., Chicago, Ill., on the 24th of May, 1865, from ingots produced in experimental Bessemer steel works at Wyandotte, Mich. They were not many in number, and were made on the regular iron rail rolls of the mill. Several of the rails were placed in local railway tracks and gave good service.

The first production of steel rails in this country on a commercial order was at the Cambria Iron Co.'s mill in August, 1867, for the Pennsylvania R. R. Co., from ingots made by the Pennsylvania Steel Co., near Harrisburg, Pa. The converting works of that company were completed some time in advance of their rail mill, which led to an arrangement under which the ingots were sent to Johnstown to be hammered into blooms which were then re-heated and rolled into rails. The steel was made under the management of Alexander L. Holley, then in charge of the Pennsylvania Steel Co. George Fritz was the chief engineer and general superintendent of the Cambria Iron Co., while I was in direct charge of the steel department. From this time the production in America of Bessemer steel rails increased rapidly.

At first all of the American Bessemer Works pursued the English plan of reducing the ingots into blooms under steam hammers. The success in rolling 8½-in.x8½-in. Pennsylvania ingots at Johnstown led to the invention of the American blooming mill, and this soon completely superseded the steam hammer in rail-making. This idea originated with George Fritz. A. L. Holley and he were intimate friends and freely exchanged views. The latter had severed his connection with the Pennsylvania Steel Co., and returned to the Troy, N. Y., Works. There he built a three high blooming mill. While it had tables, their rollers were not power-driven, and the ingots had to be pushed into the rolls, and turned over on the tables by hand. Soon after, George Fritz built a blooming mill at Johnstown in connection with a Bessemer converting plant, and put into use his patented ideas of driven rollers,

hydraulically-controlled movable rolls, and a turning over and sliding from pass to pass device. This latter the mill hands christened a "go-devil." This was the birth of the American blooming mill. It also permitted the economical handling of larger ingots.

Perhaps these details apply more to rolling mill practice than to the rails themselves; but, in my mind, they have played a most important part in the character of the steel rails made, and are pertinent. Holley started the innovations by which the production of steel ingots has been so greatly increased. George Fritz gave the blooming mill, which would not only take care of all sent to it from the converting works, but, like Oliver Twist, ask for more; and the lamented Capt. Wm. R. Jones, Robert Forsyth and several more good people built rail mills which were not satisfied with the amount of steel sent to them by any blooming mill. This has all been magnificent. It has made possible undreamed of low prices for steel rails. It has helped to build railroads, but it is not certain that it has proportionately improved the quality of the rails produced.

Steel rails, when first manufactured, replaced iron ones, which, through their deteriorated quality, and the increased duty demanded of them, were giving most unsatisfactory service. Some of the early steel rails failed, but the most of them were so much better than the best of their predecessors, that such failures did not excite adverse comment. They were of what would now be considered light sections, and so in their production from the 6-in.x6-in. or 7-in.x7-in. blooms from which they had been rolled, had received much work, and at a comparatively low temperature. In my judgment, the greatest factors in the production of good rails are covered by the words "work" and "temperature." All steel men know that work at high heats does not change the grain of steel at all in proportion to work given at lower temperatures.

For years after the introduction of steel rails, a 65-lb. per yard section was considered a heavy one; in fact, in America it was the heaviest used, and much the largest percentage was not over 60 pounds. These were rolled from 7-in.x7-in. blooms. The ingots from which the blooms were made generally 12-in.x12-in. After the bloom was formed, it was carefully examined after becoming cold, and all cracks and me-

chanical imperfections were chipped out. Then, after slow heating, with care to avoid too high a temperature, the blooms were rolled into rails by light reductions. While this was being done, should a defect show itself, the process was stopped, until it was chipped out. This slow work at a moderate and steadily decreasing temperature resulted in a fine-grained metal, which, of necessity, comparatively regardless of what may have been its chemical composition, would give greater resistance to the wear of traffic than can be possible from the coarser grained steel which is in the head of the heavier and more rapidly rolled sections of to-day.

If you wait long enough, the things of the past always become claimed as the best, which claim may be accepted, provided you do not too closely examine into that past. It must be remembered that the early rails replaced a much inferior article; in fact, created a revolution in railway maintenance of way. Hence, if a few from any cause failed, it excited little comment—they were quietly replaced by others. After a while these failures were forgotten, and the whole lot of existing rails were instanced as examples of what rails should be. Another thing which must not be overlooked is that the early steel rails had the ultimate stress of traffic applied by slow degrees. In other words, the traffic to which they were subjected when first put in service, was, for them, light duty. Heavier rolling stock, faster and more frequent trains came gradually. The old time rails which are in these later days so reverently mentioned, had been subjected by the traffic over them to a cold-rolling process before given their severest task. To-day an 85 or 100-lb. rail is hardly cold before a 175,000-lb. locomotive, hauling 100,000-lb. capacity cars at 35 miles per hour, and limited expresses of heavy Pullmans at 60 miles per hour are thundering over it.

The details of manufacture of steel rails changed, not only in America, but also in England and other countries. This had to be, and it would be as impossible to return to all the details of the earlier methods as to restore the service of stage coaches.

By way of relieving my patriotic feelings, in 1876 I read a paper at the Philadelphia meeting of the American Institute of Mining Engineers, on the "History of the Bessemer Process in America." With great pride I chronicled that the

North Chicago Bessemer Works had in a single month produced 6,457 gross tons of ingots, and that it led the world's records. These ingots were all rolled into rails. To-day, the North Chicago converting works and rail mill are abandoned, their places having been taken by the present South Chicago plant of the Illinois Steel Co., in which rail mill the largest month's production has been 77,186 gross tons of standard sectioned rails.

While the faster work of modern practice has somewhat altered the character of the steel in rails, it must not be assumed that product has been increased without any regard to other considerations. That is not true, but, on the contrary, the outward character or finish of the rails has been improved to a radical extent. While working fast, the improved machinery is also reliable, and the care exercised in keeping true to section, square sawing, accurate drilling, and straightening of both line and surface, yields results which it would have been impossible to have obtained in the earlier days. In fact, the requirements of the railways in consequence of increased weight and speed of traffic, etc., have made it imperative that such finished rails should be given them. I do not want to draw any invidious comparisons, but, in my judgment, American makers are to-day not only turning out the most rails, but, at the same time, the best finished ones now produced. Moreover, the wear of foreign rails imported into the States and Canada during the late years have not been any better, if as good, as the American-made ones.

I have intimated that sometimes examining into the past disproves assumptions. So, while in the earlier days, rail steel and rails were made with all the time and care which I have described, all the rails produced were not satisfactory; in fact, the experience of the Pennsylvania Railroad was such that their accomplished chemist, the late Dr. Charles B. Dudley, made an elaborate investigation into the chemical composition of their satisfactory and unsatisfactory rails. His deductions were presented to the American Institute of Mining Engineers in October, 1878, and elicited a memorable discussion. But it cannot be safely claimed that the present rails, whether made in America, or imported from Europe, are giving absolutely satisfactory results. They are permitting the accomplishment of that over them, which, but a little while

ago, would have been considered an impossibility. Still, if engineers had been absolutely satisfied with that which was, progress would have halted. So now we want heavy sectioned rails which will yield safer results than are now being obtained.

In the old countries railroads were built because there was a population whose needs demanded them. In this country they were often built because there was a tremendous amount of country and no population. This led to cheap construction, but while we still have plenty of room for more people, our country has become rich enough to justify the best of railroads, and, in fact, imperatively demands them. Of necessity, as the weight of rolling stock, speed of trains, and amount of traffic increased, it became imperative to improve and strengthen not only railway bridges, but also roadbeds, of which rails are the most important factor, but not by any means the only one demanding constant attention. It was also natural, as the railroad companies were then much more independent of each other, and hence, there were many more operating organizations than in these later days, that the various railway engineers should adopt different sectioned rails, which led to unsatisfactory commercial and engineering conditions, and provoked much discussion, with the result that the American Society of Civil Engineers appointed a committee on "The Proper Relation to Each Other of the Sections of Railway Wheels and Rails," which performed its duties in a thorough manner, and following and resulting from its reports, the Society appointed a committee to consider and recommend a series of standard rail sections. This was in 1891, but the final report of the committee was not made until June, 1893, (Vol. XXVIII). As secretary of the committee during the latter part of its work, I know the difficulties and labors of the task, and, naturally, am gratified to know that the recommended rail sections became practically the standard ones for American railroads, and so remained until a few years ago, since when, the sections recommended by the Rail Committee of the American Railway Association have largely replaced them in favor.

Geographical, and incident thereto, commercial conditions must govern. When the Bessemer process was first introduced in America, imported English pig irons were used in making the steel. American irons were experimented with

and gradually displaced foreign. This practice first prevailed in the works located west of the Allegheny Mountains. They soon relied entirely upon charcoal pig made from Lake Superior and Missouri ores. This was much higher in phosphorus than the English irons, but the results obtained from it were so satisfactory that the investigation continued and extended to the use of American mineral fuel irons, both anthracite and coke. After a time, these completely displaced both foreign coke and American charcoal brands, in both western and eastern works. It happened that while the most available western ores contained percentages of phosphorus fully up to the limit possible for Bessemer uses, the cheapest eastern ores were quite low in that obnoxious element. Hence the rail makers located east of the Alleghenies could produce rails low in their phosphorus contents while using for them the lowest priced pig metal. The opposite was true of the western mills. These geographical and commercial conditions led to the use of entirely distinct chemical specifications for Bessemer rails in the two districts—at least by some of the leading makers in those districts.

As I have said, the heavier equipments and higher speeds required more rigid roadbeds, which could only be obtained with heavier sectioned rails. These were gradually adopted. It was naturally expected that as the sections were increased, so would the resulting amount of service yielded by the rails. From the very first, the obtained results were disappointing, and I doubt if we ever succeed in getting as satisfactory ones as were yielded by the lighter sections. As the area of the section is increased, so, of necessity, will the work upon the steel in forming it be decreased, and, as the resulting mass is enlarged, so will the amount of heat retained in it at the time of the final reduction through the rolls be increased.

My experience as a steel maker and an observer of the wear of steel rails of many sections and diverse chemical composition, leads me to advocate, first, careful heating of the steel, and then work, continued until the temperature of the steel has been much reduced; secondly, that the carbon percentages shall be judiciously increased in proportion to the increase of rail section, the ultimate amount, of necessity, limited by the contained percentage of phosphorus, and also by the known effects of carbon on steel.

In all cases I advocate the use of drop tests on samples from each ingot of all heats of steel.

At present practically all American railway engineers use the drop test, and, while many of them limit the amount of deflection and elongation under it, none of them demand the static or tensile tests insisted upon by so many engineers of other countries; nor do I think there is any necessity for these latter. I believe the chemical analyses and drop tests are all sufficient, provided a nicking and breaking test of the tested pieces is added.

All steel rails are made from steel ingots; steel ingots are formed by pouring or casting liquid steel into cast iron ingot moulds. The larger the cross-section. and the greater the length of the ingots, the greater the difficulty in obtaining sound castings, i. e., sound and homogeneous ingots. Without sound and homogeneous ingots, it is impossible to produce sound and homogeneous rails, and, unfortunately, the most important unsoundness will be, firstly, in the center of the ingot, and lastly, in the center of the rails produced from it, and where it is frequently impossible to detect it without destroying the rails.

The large tonnage in each heat of rail steel, whether made in the Bessemer converters or open-hearth furnaces, under present mill practice, necessitates the casting of ingots of large cross-section, and long enough to make several rails. It is a long known fact that the greater the mass of steel in a casting, the greater the tendency of the metalloids (carbon, phosphorus, manganese, sulphur, and silicon, and particularly the hardening ones of phosphorus, carbon and manganese) to segregate at the part of the casting where the metal remains longest liquid, which, under normal conditions, is at the center of the mass. Again, it has long been known that the necessary cooling of the metal from the outside inwards causes a contraction which results in the formation of a cavity or "pipe," which defect is increased by hasty and uncontrolled casting of the molten steel into the ingot moulds.

Over twenty years ago, Mr. Robert Forsyth, then chief engineer and manager of the Union Steel Co., Chicago, Ill., demonstrated that if rail steel ingots were laid on their sides before the interior steel had set, the pipe would not be formed in the middle of the top end of the ingot, but, upon the upper

side, and liable to extend well toward the bottom end, and that, therefore, ingots should be left standing in a vertical position until the interior metal had solidified. (See Journal of the Franklin Institute, Vol. 127, May, 1889.)

As the general conditions produce ingots with the most undesirable steel in their upper part, it has been and is the practice in manufacturing steel locomotive tires, ordnance forgings, armor plate, large steel shafting, and other what are termed high-grade products, to arbitrarily reject at least the upper one-third of the ingot. It is true that even so great a discard will not always prove an absolute safeguard, but, if the ingots are carefully made, it will do so. Against bad or ignorant workmanship it is hard to find any absolute protection. In rail purchases it has so far been found impractical to secure so great a discard. Personally, I believe the future will bring it through the rail makers developing other uses for the discarded steel, or else means of casting sound ingots will be adopted.

Experience has proven that rails made by the basic open-hearth process are more liable to have interior pipes and segregated spots than Bessemer ones, no doubt principally because the ingots are larger and the size of the heats prevents slow casting. We know that many unsound open-hearth rails have been, and, I fear, are yet in service.

I believe we can afford to leave the chemical requirements remain as they are in most of the specifications; the physical requirements as to temperature are sufficient, and most of them provide for sufficient drop testing so far as determining the quality of the steel as metal, but they do not go far enough to give protection against unsound castings, that is, ingots. Practically all specifications require that the test piece shall be taken from the upper end of the rail made from the top of the ingot, and several that, after drop testing, if the piece has not broken, it shall be nicked and broken, and, if the interior of the rail shows any defects, all of the A, or top rails of the heat shall be rejected. So far, so good, but each ingot is an individual or separate casting, and, because one is sound, it does not prove that the other five in the heat of Bessemer, or nineteen or more in open-hearth practice, are also good castings.

I have repeatedly shown that without sound ingots there

will not be any certainty of producing sound rails; and that, as each ingot is an individual steel casting, some means should be adopted of testing for soundness the rails produced from each ingot; and until reliable ways of casting sound ingots are adopted, the importance of such testing should not be overlooked or underestimated. It is possible to make sound ingots. It will cost more than the present practices; but is that a good argument against it? Whether that increased cost should be added to the selling price of rails, is a commercial question outside of the province of this paper. The increased cost of individual ingot testing is so small that it should not be a matter of much commercial importance.

One of the most serious and important economic administrative problems facing American railway authorities to-day is that of their rails, and it is one to which much thought is being given, not only by the executive officers of the railways and the manufacturers of the steel rails, but also by state and national commissions. It is realized by many and admitted by some that the present situation is one which cannot continue. The roadways of railways must be made more secure, or the weight of rolling stock and the speed of trains must be lessened; and the desired result must be attained with the minimum outlay of money, both in expenditure on plant and in cost of operation. If the investment per mile is too large, or through the lessening of tonnage and efficiency of equipment the cost of operation is too great, the desired and demanded cheap service cannot be rendered to the public. Therefore, the weight of equipment cannot be greatly reduced, and lessening the rapidity of service would be far from satisfactory; consequently, the safety of the roadway must be secured with the least practical outlay.

It is imperative that the roadbed should be properly graded, with the fewest practically possible curves; that it should have good ballast, be well drained, have good ties properly spaced, and be laid with sound rails of suitable weight, efficiently joined together, and that the whole property be carefully and intelligently cared for.

During the last few years there has been renewed interest in and discussion of the rail question, and I know that many rail makers not only have been and are desirous of maintain-

ing the highest standards of manufacture which they may have attained, but have been and are seeking to better their product, in several instances devoting much time and money to that end. At the same time, they realize that the cost of any improvement in quality which they may accomplish must be kept within certain commercial bounds; and that fact is as fully understood by their patrons as by themselves, and it should be kept in mind by all who discuss the question.

As you no doubt know, in the acid Bessemer process, and which is the only one used in this country, the amount of phosphorus contained in the iron treated is increased by the operation to an amount practically equivalent to the loss incident to the process, say about 8 per cent, and, as it has been proven that Bessemer steel rails cannot, under any conditions, safely have over 0.10 per cent of that element, you appreciate that only such ores as will yield metal low enough in phosphorus to give such results can be used. The known supply of such ores has become more and more limited; while, on the other hand, the demand for rail and other construction steels has steadily increased, hence, the necessity for and providential discovery of the basic open-hearth process, in which the phosphorus can be reduced instead of being increased. This has resulted in rails made by that process being used instead of Bessemer ones, and the lower phosphorus permits the safe use of higher carbon, and thus yield harder and stronger steel without unduly sacrificing its ductility, and thus, safety in service.

The size of the furnaces in which open-hearth steel is made has been steadily increased, until the later ones yield 100 tons of molten metal at each heat; this received in and cast into ingots from one ladle, so I think you can easily appreciate that the workmen have trouble in exercising much care or control as to what kind of castings, i. e., ingots, are produced, hence the pipes, etc.

One thing that, in my judgment, has had a great effect upon the quality of the product of all the mills is that the workmen have been and are paid on a tonnage or piece basis, with, in some cases, an additional prospective bonus based on quantity of product. Unfortunately, after the produced rails had left the works, there was but little chance of the identity or individuality of the workmen in the different

departments of the works, who made them, being connected with them. It is true that a number corresponding with that of the heat of steel from which they had been rolled, and the month and year in which they were made, and the name of the works, were branded on each rail, but to actually identify the steel maker who made the steel, the heater who heated it, the roller who rolled it, the shearman who cropped the blooms, etc., would have been a complicated and practically impossible proposition. One result was that if, for any reason, such as delays from accidents to machinery, etc., the quantity of product was threatened, there was temptation to in some way cut corners, the workmen knowing that if the rails were once out of the mill they need not worry over any individual responsibility, which feeling was simply human.

In an endeavor to meet this and other phases of the situation, some two years ago I ventured the establishment of a system of more constant and thorough inspection of rail making than had been generally, if at all, practiced. In this movement I received the support at first of several and later of many of the railroad companies of this continent, and I am happy to say that I have also received the loyal support of the officials of the several steel companies.

Under this system inspectors are placed day and night in each department of the rail works, commencing in the steel producing plant, and so on through all subsequent operations, until the finished rails are loaded on the cars for shipment. They are not to interfere with the men, but to carefully observe, record, and report all that happens, should it be either contrary to the specifications under which the rails are being made, or contrary to the established practice of that individual works; and it is their duty to, at the time of the occurrence, call it to the attention of the foreman in charge of that particular portion of the work. These reports ultimately reach the proper representative of the purchasing railroad, and as they specify the heat or heats of steel to which they apply, and as each rail is stamped with the number of the heat from which it was rolled, the reports constitute a record of the making of every rail, and thereby, to a large extent, individualize the work of the men who made them. The workmen appreciate this, and I know much good has been accomplished.

There is another feature of the situation which demands and is receiving serious consideration from railway officers, consulting engineers, the steel works officials, and others; that is, the desirability, if not absolute necessity, of increasing the weight of rail sections. A number of such sections have been designed, and some have been rolled, and the rails are in use; but there is a metallurgical feature involved which should not be overlooked.

As I have stated, the experience of many railways has been that their earlier rails, which were of lighter sections, gave better service than the later heavier ones, and the track men will tell you that when they cut one of the old rails, they found a close, fine-grained structure, while the larger rails show a more or less coarse one. The old lighter rails permitted the fining effects of the rolling to penetrate, and the mass of metal in their heads being comparatively small, the effect of the interior contained heat passed off sooner. The rolling conditions result in the webs and flanges of all rails having a finer structure than their heads; therefore, as we increase the size of the rail sections, we will certainly decrease their proportionate strength, and under present manufacturing conditions, the heavier rails will have less resistance to the abrasive wear of traffic. Nevertheless, there seems to be a necessity for heavier rails, and so much the better, if we can also make them proportionately stronger and resistant to traffic wear. Excepting in the ability to roll rails by the use of fewer passes in the rolls, and to handle the operations mechanically and automatically, there have not been any radical changes in rail rolling. The plan of rolling reductions has remained much the same. Some experiments have been made, and various schemes have been proposed, but none of them are in active use. In my judgment, the present situation demands serious consideration, even though it should require very radical changes in the rolling machinery of the existing rail mills. If we must have rails with more metal in their heads, as well as thicker webs and flanges, it is most important that the work of reduction and formation from the, say 8-in.x8-in. section of the blooms shall be applied in a way to penetrate and fine the metal in the rail heads. I shall not here attempt to particularize the way, but it can and will be done.

Once more I emphasize the truth that the physical treatment of the metal is of at least equal importance with its chemical composition.

DISCUSSION.

Mr. F. G. Jonah. I do not believe any thing can be added to the splendid presentation of the history of rail manufacture as we have listened to it this evening. There have been three distinct steps in the advancement of the process of rail manufacture: The discovery of the Bessemer process, the adoption of uniform sections and the open-hearth process.

The engineers can take great pride in their work toward the adoption of uniform sections. Prior to that, the manufacturers, chief engineers, presidents and other officers of different railroads would make the rail sections to suit themselves, and a 60-lb. rail on one road might not look much like a 60-lb. rail on another, or a new 85-lb. rail on an eastern line might not look like a new 85-lb. rail on a western line. Consequently, angle bars and fastenings had to be made especially for every rolling of rail.

After the adoption of a standard section this difficulty was removed. Angle bars made for one weight of rail could be used all over the country on that same weight of rail, necessitating only perhaps change in the punching.

Those of us who have had experience in handling rail long ago realized that the smaller sections of rail wore very much better than the larger rails which we are now getting, and the paper of this evening shows us clearly why we cannot expect as good wearing rail on the larger sections as we used to get on the smaller.

The smaller rails were gradually discarded for the heavier weights because they did not have sufficient section to make them rigid enough to take care of the increasing axle loads.

We learn from the discussion this evening that it may be possible to get large section rails made which will wear as well as the old smaller sections, and this will be brought about by better inspection than the rails have been getting lately, and no one has contributed so much to good inspection of rail as Mr. Robert W. Hunt.

Mr. C. E. Smith. I find that the average railroad man depends a great deal upon Captain Hunt and his associates to tell him what is a good rail and what it is manufactured from.

For a good many years our Company has depended on the Hunt Company to look after our rail inspection. The 90-lb. rails we are putting in track do not break very frequently; perhaps it is due to the fact that we do not have, out in this part of the country, the very heaviest locomotives. We have some locomotives with 60,000 lbs. on each driver axle, but most of the locomotives are considerably lighter. I have no doubt, however, that there will be heavier locomotives and that there will be necessity for further study to determine the cause of rail breakages.

That the breakages are undoubtedly caused in part by weight of equipment is indicated by the fact that on some lines we have had rails in track for 10 or 12 years under very light traffic with few, if any, breaks, but as heavier locomotives were put on the same track, numerous breaks would occur.

Another matter that requires attention is the question of re-rolled rails. We recently re-rolled a lot of rails which had been in use for a great many years on heavy traffic lines without any breakages. When, after re-rolling, these rails were put in use on lighter traffic lines, there were very many breaks and we are trying to find out now why these rails, which possibly had defects before re-rolling, did not break on the heavy traffic lines but did break so much more when put in lines under lighter traffic.

Mr. R. E. Einstein. I do not know a great deal about the composition of steel rails, but have had considerable experience fabricating them in the manufacture of frogs and switches. We have found in late years that the usual rolled rails used for this purpose, which seems to have answered years ago, are entirely too weak and give out quickly under the present heavy loads and fast traffic.

The best practice at present is to use a better grade of material for frog and switch material—like cast manganese steel. We are also using quite a little manganese rolled rail, which is of similar composition and has the same qualities as the cast manganese, and which is very difficult to work.

I should like to ask Mr. Hunt how much of this rolled manganese rail has been used on main line track, and what service it has given? We are getting good results from it in

frogs and switches, but whether the use of this rail on track in view of its high price is successful, I have not heard.

Mr. Robert W. Hunt. It is being used experimentally, but I do not think enough to really answer your question; that is, to make a positive assertion. The subways have used such rails very satisfactorily in New York; the Erie has had some unsatisfactory experience, still their trouble seems to have been due to local causes. I do not mean local to the Erie, but a matter which happened in the manufacture of these particular rails. Its manufacture is in its infancy. It is a very peculiar thing. Such rails as rolled are as brittle as glass, but, plunged into water while red hot and so cooled, they become so tough you cannot break them. The South Works of the Illinois Steel Co., are rolling a good deal of such steel. The price was $125, and I think they are now selling the rails from $80 to $90 per ton. With their electric furnace at South Chicago, they are better equipped to make the high manganese steel than anybody else in this country. They are in it determined to make a success.

Allow me to say to you, gentlemen—perhaps some of you are not familiar with it—this metal is a very beautiful illustration and a very peculiar illustration of the effect of manganese. If you put in up to one per cent of manganese, which is the common per cent used in all steel rails, you will get the desired purifying and solidifying effect, but put in two, three, or four per cent, and the steel will be so brittle you cannot use it, but go on to 12 or 14 per cent and you get this tough material that is so hard to break.

Mr. T. R. Akin. Perhaps some of you do not know that we had a large rail mill in Carondelet (St. Louis) which made Bessemer rails up to some time in the eighties; and later than this, Bessemer rails were made at Belleville, Ill., up to 1893. This latter plant, where I had my first experience, operated five-ton vessels with a maximum of 33 heats in 12 hours, which, in comparison with the large Bessemer plants of to-day, with 10 or 15-ton vessels and making over 100 heats, shows how the capacities have changed. This plant made excellent steel from Missouri ores, but with the development of northern Bessemer ore mines, competition became impossible.

I wish to emphasize what Captain Hunt has said regarding the necessity, in making inspections, of going beyond the chemical analysis. At one time when I was located at Youngstown, Ohio, we undertook a large contract for Bessemer steel skelp for pipe and investigated the proper methods of making the same. The results showed that at times a piece of pipe of good analysis would not weld properly or perhaps take a thread, while another piece with an analysis which would indicate segregation and poor quality, would make a perfect pipe. The results of very many analyses showed that we could not be sure of good pipe from analysis alone, and we therefore had to attain proper results by doing just what is proposed in the inspection of rails to-day—beginning with the pig iron and following every process through the steel plant until the skelp is rolled.

The whole thing has been shown by Captain Hunt to-night—that someone has to watch the entire process and you cannot pick out and say that one analysis or another will give you the best results.

Mr. C. L. Hawkins. The United Railways Company depends very largely upon the Hunt Company for information in regard to rail analyses and inspections. In regard to trouble occurring when the weight of cars has been increased, referred to by Mr. Smith, I might add that the United Railways Company also has had some trouble of that kind. We often find that where a rail has been in use from five to ten years and where the rail and joints are still in very good condition, an increase in car weights from 40,000 to 50,000 lbs, will soon cause a large amount of trouble in breakage of rails and failures of joints. In order to take care of the increased loads and also to more properly reinforce the heads of girder rails a large percentage of the street railway companies have increased the weights of rails ten to fifteen per cent or more during the last ten years. The stresses in street railway or girder rails are a little different from those in steam railroad rails on account of the fact that the rails are generally laid on a rigid foundation and the action of the wheels is somewhat similar to the action of a sledge hammer striking on material laid on an anvil.

Mr. F. E. Bausch. How do the locomotive wheels affect the character of rails in breaking them?

Mr. Robert W. Hunt. Rails have been broken by flat wheels. The Southern Pacific, I guess it was on one of the Union Pacific branches of what was the Harriman Lines, had a very illuminating illustration of that. They had a coal property out west that had a very heavy grade; that is, a heavy grade to the property and, of course, the reverse going to the main line, so that after the coal cars were loaded, they used the breaks very heavily bringing them to the main track, with the result that they slid the wheels, and that was well calculated to produce flat wheels, and on the section of track on which those trains were put into traffic, they broke rails so fast that it was appalling, and examination convinced them that it was the effect of flat wheels.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

TARRANT COUNTY, TEXAS, HIGHWAYS.

By J. C. TRAVILLA,
MEMBER OF THE ENGINEERS' CLUB OF ST. LOUIS.

[Read before the Club, May 27, 1914.]

During my term as Street Commissioner in St. Louis, I took a great interest in the cheaper forms of construction, as well as in the more modern city pavements, hoping the opportunity, some day, would come where I could take advantage of that knowledge and apply it on a larger scale. When I heard of the opening in Texas, the job appealed to me. I had no appreciation of the magnitude of the State—its topography or the climatic conditions, or what I was to be up against; but to my friends I want to state that I think it is the most wonderful State in the Union. The opportunities down there for engineers, especially in highway construction, are greater than in any State that I know of. I have kept in touch with highway work in all the States and, outside of a few of the Eastern States, there is not any State in the Union that is doing as much public work as Texas. I left Texas hurriedly a week ago last Saturday, called East on account of a death in the family, and brought a number of slides with me and prepared a short paper. I will go into the general details of the work when the slides are shown.

The construction and maintenance of highways are now considered engineering functions worthy of the attention of the best engineers. It has been only within recent years that this is true in this country. In European countries the importance of the work has been recognized for years. Less progress has been made in the science and development of highway construction than in any other branch of public work; it cannot be said that it is keeping pace with the great development in vehicular traffic. Only a few road engineers appear to show initiative and independence of thought in developing their ideas and the majority seem to adhere to the old types of road construction to a far greater degree than is justifiable. To-day our universities are providing special courses in highway engineering; the technical journals are featuring the subject and good road boosters and associations are to be found everywhere. I believe there is a greater field

for engineers in highway construction than in any other branch of engineering.

The public has been slow to recognize the need of competent engineers to direct such work and the loss to the State and country due to inexperience and misdirected energy is in evidence everywhere.

Twenty-five years ago many of us began our engineering work on the railroads and the training received is valuable in highway construction. Many of the technical and economic problems are alike. I am of the opinion that more judgment and skill are required in highway work than in railroad work.

Fort Worth, a city with a population of 100,000, is the county seat of Tarrant County. A personal and lively interest is manifested by the people of the city in the roads being built, as they pay 83 per cent of all the taxation of the county. The roads were planned on a comprehensive system designed to best serve the interests of the people of both the county and the city and those of adjacent counties who do business with Fort Worth.

All the roads radiate from Fort Worth, eight in number, now known as the Cardinal and Sub-Cardinal roads, so named for the reason that they follow, in a general way, the cardinal compass directions, the sub-cardinal roads being within the intervening angles.

Texas Laws.

The laws of Texas place the highways under the control of commissioners elected every two years. Each county is divided into four road-precincts and a commissioner elected for each precinct. These commissioners form what is known as the Commissioners' Court. The presiding officer is a judge who is elected at large. Meetings are held semi-weekly, the remainder of their time is given to the superivsion of road work done by day labor or by convicts.

The State is without a highway department and there is no one to systematically plan and direct work except when an engineer is selected, as in the case of Tarrant County. The necessity for a state highway department is recognized by many and the required legislation will probably be obtained in the near future.

The good roads movement has grown very rapidly in Texas. Counties, precincts and special road districts are voting bonds for the improvement of the highways to such an extent as to make Texas conspicuous. In the year 1912, $4,600,000 in bonds were voted upon and carried; in 1913, $7,000,000, and since Jan. 1914, nearly $3,000,000 have been voted.

It requires a two-thirds vote to carry a bond election, so you can see that the "good roads germ" is at work. For systematic road improvements, it is necessary to raise money from the sale of bonds, a special or direct tax would be too much of a burden unless spread over a number of years. Many features of highway construction are permanent, necessitating a proper charge against bond issues extending over a long period, such as right-of-way, grading, drainage, bridges, culverts, etc. There are certain features connected with highway bond issues which should be given more attention. In the first place, such bonds should not be issued without a definite plan for financing annual repairs and maintenance; either by an annual tax for this purpose, or the setting aside of a portion of the bond issue for the upkeep of the roads during the life of the bonds.

Bonds are usually issued for a period of twenty years; there is some doubt as to this length of time,—in all probability it is too long; therefore the work should be as nearly permanent as possible. The motto for roads built with bond money should be "not how cheap, but how well," as the best road will prove the cheapest road.

Traffic.

In planning a comprehensive road system, consideration must be given to the character and amount of traffic, remembering that good roads invite and increase traffic and that the density of population is increasing. The traffic may be divided into urban, suburban and rural and it may be stated that the requirements of roadway paving differ in character according to this subdivision. Traffic should be taken for a period during the different seasons of the year. From the traffic census you are in a position to determine the character of construction and width of roadway.

Planning.

Good alignment, the elimination of grade crossing and sharp curves, and the reduction of grades are important features of road planning. It is necessary in planning to adapt your plans and specifications to meet local conditions, making use of all local materials that are in any way adapted for the work. In Texas you will find a great variety of materials that can be used in the construction of roads. Along the Gulf Coast the available material is shell—10 to 20 per cent of mud is desirable in the shell to fill the voids. In many parts of the State you will find sand and clay for constructing sand-clay roads, and limestone for macadam roads.

In Tarrant County there is a poor grade of disintegrated limestone that is suited for base material; also a formation of gravel that carries an excess of clay that does not make a good wearing surface but is well adapted for the base and shoulders of roads. The limestone used for the wearing surface is shipped from quarries located outside of the county.

The first essential in road construction is the proper grading of the road-bed to grades determined after a careful study of the topography; second, the foundation or base upon which the wearing surface is to be placed, the depth of base being dependent upon the character and amount of traffic, soil conditions, etc. For Tarrant County I recommended two types of road construction as best suited for the local conditions, known as Class A and Class B. In both classes local material is used for the base and imported stone for the wearing surface.

The improved roadways will average 8 to 9 in. in depth after compression, the base being 4 in. and the crushed stone 4 inches. The stone is separated at the crushing plant into four sizes:

No. 1	stone,	ranging	in	size	from	1½	in.	to	3¼ in.
No. 2	"	"	"	"	"	½	"	"	1½ "
No. 3	"	"	"	"	"	¼	"	"	½ "
No. 4	"	"	"	"	"	dust		"	¼ "

This grading requires a standard screen with a "dust jacket" (¼-in. perforations) over the ⅝-in. screen.

In Class A, tar and refined asphalt are used for the binder, and in Class B, limestone dust is the binder. In both types

of roads, a heavy asphaltic oil is used to form a cushion coat over the stone and to act as a dust preventive.

The roadway surfaces are being built in two widths. On the heavier traffic roads when the auto traffic is in excess of the horse-drawn traffic, 18-ft. roadways are being constructed. On those subjected to light traffic 16 ft. was recommended. For economic reasons, on the less important highways I am using crushed stone for a width of 10 ft., with gravel shoulders 3 ft. wide so as to obtain the 16 ft. roadway.

Refined tar is used as a paint coat for the purpose of getting adhesion of the asphaltic cement.

The work is being done by contract with unit prices for all labor and material.

Maintenance.

To construct a road surface that is smooth and not affected injuriously in time by traffic, rain or frost, is not possible. No wearing surface will last indefinitely. Systematical maintenance in charge of competent men is the only solution for perfect pavements and road surfaces.

A patrolman should be in charge of small repairs. He should be equipped with horse, cart, small tools and road materials. On repairs too large for the patrolman, the work should be done by day labor, and on extensive repairs, like re-surfacing, the work should be done by contract.

The road menders should be kept constantly at work, as the "stitch in time" principle is very applicable to road maintenance.

The excess cost of maintenance over what might be termed a normal charge due to traffic and climatic conditions may be attributed to poor foundation, poor drainage, poor stone and binder and improper grading of the stone.

General.

I have given publicity to all our expenditures on each road. The press publishes monthly a statement of our expenditures. I have been working to obtain the maximum efficiency and economy consistent with good work, believing that the public will be better satisfied in the end to have fewer miles of well improved roads than to have more miles of makeshift roads; both kinds have to be maintained and the former

is the cheaper in the end. One reason for so much faulty work is that bond issues have been made with the assumption that so many miles of roads could be built, but when the work was started, in order to get in the mileage and satisfy more people for the time being, the road construction was slighted. Estimates should be made by the engineer before a bond issue is made, just as the builder has prepared an approximate estimate of cost of the building by the architect before letting his contracts.

The highways are assuming new importance as a necessary adjunct to the upbuilding of our country. No short cut can be made in their development; it will require money and honest and efficient work. I know of no public work that will do more for this upbuilding,—financially, socially and morally than this great movement for better roads.

(At this point the lantern slides were shown, after which Mr. Travilla made the following impromptu remarks.—ED.)

When I went to Fort Worth to start preparations for these highways, I found a court that had planned just what they wanted. They said, Travilla, we want macadam roads 16 ft. in width. We want to have the farmers do this work by day labor. They had a number of other suggestions to make, and I said: Gentlemen, give me an opportunity to study the proposition and determine what will be best for the public interests, and after I have gone into every detail, I shall make a report. I found, as I stated in regard to the traffic, that conditions were such that near the city it was necessary to plan for a different class of travel than further out—also in regard to the width of the roadways—so, on some of our roads, I planned 18 ft. leaving the city, reducing down to 16 ft. with the rock, and then down as low as 10 ft., because, from studies I had made, I realized that if we were to cover the territory and get the roads desired, it was necessary to give considerable thought to the character of the wearing surface, as that was going to be a very great expense. Then, again, I found various interests working, not only on the court, but on myself, to recommend special types of roadways, patented pavements, vitrified brick roadways and concrete roadways. I was willing to meet all of the different interests and tell them that I was not wedded to any form of construction. My object was to recommend what would

be to the best of interests of the people in the city and the county.

After spending five months in making the surveys and the estimates, and preparing all the details, I was able to satisfy the court and the public, in a general way, as to the work which I was about to undertake. A job of such magnitude attracted a great deal of attention and I felt it was too large to have one contractor figure on 133 miles of roads. I divided the work up into ten sections, thinking in that way it would offer an opportunity for the contractor with less capital to get into that line of work, but was disappointed when I found, at the day of letting, that one contractor was the lowest bidder on all ten sections of the highways. I said to the president of the contracting company: It is very unfortunate that you are the lowest bidder on all of this work. You do not appreciate the magnitude of the job, or what you are up against. He said: "Do not worry about us, we have built miles and miles of roads, and we have the money and equipment to carry out these contracts."

This contracting concern had built gravel roads in a number of counties, where they simply went to a gravel pit, loaded the gravel, pulled it on to the roads, and pulled a drag over it, and that was the nature of the gravel road construction. They did not know what it meant to build roads of crushed stone; nor understand the application of oil, tars and asphalt to bind the stone together. Nevertheless, ten of these contracts were awarded to one concern. My trouble started at that time. It was necessary to educate the men up to the standards called for in the specifications, and I found them willing and anxious to endeavor to carry out our work to the letter, but the prices that they bid for the work were such that, in the course of six or seven months, they began to realize that they were not making money. Fortunately, at the time of the letting, we not only had the protection of the surety companies, but we had one of the largest banks in the city as surety to protect the county. The contractor was obliged to quit the job. The surety companies and the bank formed a new company and took over the work, so that the man I started out with, who was going to do wonders and knew all about the job, I have not seen for the last four or five months,

but I think he is wiser about building asphalt-bound macadam roads and water-bound macadam roads.

So, in starting out I had my troubles, but I have enjoyed the work. It has been a great pleasure to educate those people up to higher standards. I am glad to say that the engineers of Texas have taken a great interest in me and my work. We have had two schools of instruction; one at Corpus Christi last summer and another meeting during the winter. These meetings for the road engineers of the State have been extremely interesting and beneficial to all concerned. We have the engineers come into Fort Worth to look over our work, also the students from the universities, so that we have raised higher standards for the engineers in that part of the country.

DISCUSSION.

Mr. ————. What do you get for your bonds?

Mr. J. C. Travilla. They brought a little more than par. There is one thing I might bring out in regard to bonds just at this time. I told you that $13,000,000 or $14,000,000 had been voted in bonds, but only the big towns, at the present time, are able to sell their bonds. Waco had a big bond issue recently and they sold their bonds a month or two ago at par, but the bonds of Texas are not desirable paper at this time. I had work at Mineral Wells where they had $100,000 in bonds and they had no trouble selling the Texas bonds. The only reason they have trouble selling bonds is that they bear only five per cent interest. In towns where they have only $500,000 or so, the banks carry them until such time as they can get par for them.

Mr. ————. Where do they go, east, or are they taken up locally?

Mr. J. C. Travilla. Chicago people take a great many of the bonds. St. Louis has, until recently, taken a great many of them. Another reason why the bonds of Texas are not selling better is because the drainage bonds of Arkansas are bringing a better rate of interest, and they are selling at 92 or 93, and there are bonds in the east that bring six per cent; so the law is holding them back, as it limits them to five per cent.

In Houston they had a bond issue several years ago and tried to dispose of a certain amount of the issue among the business men of the city and the farmers out in the country. They did raise some money, and are doing a certain amount of work, but with us our money has been right in the bank; we are getting interest on it, paying it out monthly and have no trouble. As I said, the bonds were sold two years ago. They were over a year fussing about how the money should be spent and were pretty well mixed up.

Mr. ————. I should like to ask whether the contractors ever considered the use of a mechanical tractor in distributing the stone?

Mr. J. C. Travilla. No, sir, they have not, but over at Paris, in Hunt county, they used the tractors for some little time. The contractor figured that he could haul for about $0.08 per ton per mile. The result was that he went broke—lost $60,000—and the surety company is now finishing the job.

Mr. ————. What wages do they pay?

Mr. J. C. Travilla. Teams, $3.50 and $4.00—most of them $3.50; labor, $1.75 and $2.00 a day; but the labor down there is not the same class of labor as up here. They do not seem to have the snap and the energy.

Mr. F. W. Terpening. I should like to inquire as to what it costs per square yard for that construction?

Mr. J. C. Travilla. We are putting that down in Dallas Pike for about $0.75.

Mr. F. W. Terpening. That isn't bad, is it!

Mr. J. C. Travilla. No, sir. Really, our price is a little too low. Nobody is making any money out of the job, but it was not my fault that they took it so low.

Mr. ————. Are you striking Arlington?

Mr. J. C. Travilla. Yes, sir. We are in the town of Arlington now. We are putting in a street there that is 60 feet wide.

Mr. ————. What is the maximum width of the roads being built?

Mr. J. C. Travilla. Eighteen feet, but we have 24 feet including the earth shoulders.

Mr. ————. Are there any concrete roads being built in Texas?

Mr. J. C. Travilla. No, sir. There are not. I want to say in regard to building a concrete roadway that the people interested in the cement end of it were after me and wanted me to take up the concrete end of it. I believe, down there, we would have lots of trouble with concrete. I know they are having trouble with the concrete curbs and gutters on account of the aggregate, climatic conditions, indifference, carelessness, and the difficulty in getting water for mixing. That was a serious problem with us last summer. It has not been in the last six months, which has helped our contractors, but water last year was really an expensive proposition. At one time we figured on having it shipped in tank cars on the railroads.

Mr. ————. I should like to ask Mr. Travilla just how much rolling they do on the roads down there—that is, do you roll your sub-grades first; then roll the first grades, then the second grades and after the asphaltic cement is applied give it a final rolling?

Mr. J. C. Travilla. Yes, sir. We first roll the sub-grade, and we anchor the disintegrated stone in rolling the base. We do not attempt to roll the gravel. I do not believe very much in rolling gravel with a gravel roll. I prefer to turn the gravel in on the road and keep it dragged by using the road grader and the harrow, and in that way we usually get our road compact and uniform on account of the number of times we have been over it with the drag. But in cases where it is not compact, and it is necessary to roll or sprinkle on account of the rock, we insist on the rolling of the gravel. After the No. 1 stone has been placed, the harrowing done, and brought up to its cross section, it is thoroughly rolled. Most of the rolling is done then because you are anchoring the stone and breaking off the small points. There is such a thing, however, as doing too much rolling. You will break off the stone, get it rounded, and then it is going to roll. You cannot say just what it will do. We get limestone from one quarry that is extremely hard, and then from another quarry a soft limestone which will not stand the rolling. After the No. 2 stone is placed, the rolling is comparatively light.

Mr. W. A. Heimbuecher. The second course is just to build up?

Mr. J. C. Travilla. Yes. Then we put on our bitumen

and chips. After the first treatment of bitumen, if there are any irregularities, we roll those out each time.

MR. F. W. TERPENING. Is that just coal tar?

MR. J. C. TRAVILLA. Yes.

MR. F. W. TERPENING. Do they work well together?

MR. J. C. TRAVILLA. They certainly do. The tar sets up very rapidly and it penetrates through the dust and right into the stone. If you take a piece of lime stone and treat it with tar and heat it up to the temperature, as I say, you will find the tar has gone into the stone.

MR. F. W. TERPENING. In other words, it saturates the stone?

MR. J. C. TRAVILLA. Yes.

Mr. ——. Where do you get the tar?

MR. J. C. TRAVILLA. Some from Birmingham and some from New Orleans. I want to call your attention to this incident: Last summer I was asked to go out and look at a road which was supposed to be asphalt and macadam. I was asked what I thought of the job. I said: It looks very poor—what are you going to do, tear it up? The asphalt had not adhered to the stone at all. There had been no grading to start with. It was practically all one size at the top, and there had been no adhesion of the asphaltic cement to the top. I know of a number of failures all over the country on account of the asphaltic cement not taking to the stone.

Mr. ——. Do you believe if they used a lighter asphaltic cement on that stone it would have acted all right?

MR. J. C. TRAVILLA. I do not.

MR. E. E. WALL. We have one member of the Club here, in the Street Department, who has been down in Texas since Mr. Travilla has been working down there,—Mr. Hempelmann. Probably he could tell us something of interest on what he observed of Mr. Travilla's work.

MR. W. L. HEMPLEMANN. I had a chance to go down there and see some of the work Mr. Travilla has been doing, and probably one thing that struck me more than any other was the difference in the condition of the water supply. We are accustomed to hooking up to a sprinkler or fire plug and getting our water. One morning I was out about 11 o'clock and saw two men laboring with a small hand pump and a team. They had a barrel of water about half full. I think

the two barrels of water for that day cost about $7. That was in the water-bound macadam district. In some of the roadways that had been water-bound it was pretty dry at that time because the oil was not applied at the time the roadway was set.

One thing that Mr. Travilla's talk suggests is the fact that in the Engineers' Club, the road engineer—the man who is interested in pavements, their construction and maintenance—is probably, numerically at least, the most poorly represented. That applies also in the library. You will find in the library technical journals on almost any branch of engineering, but we have very little concerning roads.

Mr. ——. I should like to ask Mr. Travilla what he is using on the 18 foot roads?

Mr. J. C. Travilla. Asphalt. One-half inch a foot. On the water-bound macadam, I recommend three-quarters of an inch per foot.

Mr. B. H. Colby. You stated that the cost per square yard was 75 cents per foot. What percentage of that is represented by your material and rock?

Mr. J. C. Travilla. About one-third.

Mr. J. W. Woermann. You once remarked that the grade was 6 per cent and at another time 10 per cent?

Mr. J. C. Travilla. We found, on some of the roads there, a maximum grade of ten per cent and we have either changed the alignment to make six per cent or made a cut. It cost us about $20,000 to change that grade to six per cent.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

PRESERVATIVE TREATMENT OF TIMBER.

By J. M. Goldman.*

1. In all processes for the preservative treatment of wood, the kind and ultimate use of the wood as well as the degree of dryness must be considered. In the use of wood as timber for structures it has been found that coniferous woods serve best where lightness and stiffness are required;. dense coniferous woods, where steady loads are to be supported, and tough hard woods where there are jarring loads.

Seasoning is commonly understood to mean drying, but in addition to expulsion of water by evaporation other changes take place, such as the drying and partial decomposition of albuminous substances of the sap contained in the cells, leaving the seasoned wood more porous, but with less fermentable matter than when green. The time required for timber to season, cut at different periods of the year, has been determined by Forest Service Tests as follows:

Species.	Location of Test.	Time required for seasoning.			
		Spring Cut	Summer Cut	Autumn Cut	Winter Cut
Chestnut.	Parkton, Md.	5	4	8	7
Southern White Cedar	Wilmington, N. C.	3	3	8	5
Northern White Cedar	Escanaba, Mich.	12	9	7	6
Western Red Cedar.	Wilmington, Cal.	4 3	5	.3 7	.3 4
Western Yellow Pine.	Madera, Cal.	5	6	6	6

2. The artificial methods of seasoning are kiln, steam and hot-air drying. The practice in all these methods is to heat the

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timber, thereby reducing its hydroscopicity and tendency to warp, neither of which, however, can be altogether overcome, even with prolonged exposure to temperature below 200 degrees Fahr., which is found to be the maximum permissible, higher temperatures by volatilizing components of the woody fibre being injurious to the strength of the timber. The following temperatures have been successfully used and are recommended for drying without injury to the wood:

For oak and ash....................120 to 130 degrees Fahr.
For poplar..................................158 to 180 degrees Fahr.
For walnut................................ 90 to 100 degrees Fahr.
For white and yellow pines..160 to 190 degrees Fahr.

The following table shows weight lost by seasoning until approximately air-dry:

Species	Duration of Seasoning	Green, Wt. per cu. ft.	Seasoned, Wt. per cu. ft.	Wt. lost	Total Wt. lost per pole	Nominal size of poles Dia. Lgth.	Av. Vol. of poles
	Months	Lbs.	Lbs.	Per cent	Lbs.	Ft. In.	Cu ft.
Chestnut.	4-8	56	47	16	180	7 30	20.00
Southern White Cedar	3-8	a37	26	30	228	7 30	20.76
Northern White Cedar	6-12	33	25	24	141	7 30	17.62
Western Red Cedar	3-5	b33	25	24	219	8 40	27.34
Western Yellow Pine	3-9	65	33	49	835	8 40	26.10

Seasoning by allowing the smoke laden products of combustion to circulate among and penetrate loosely piled timbers has been found an excellent aid in their preservation. The

saving in freight affected by seasoning is illustrated in Forest Service Tests as follows:

Species	Seasoned poles required for min. car load, 40,000 lbs.	Total decrease in weight due to seasoning	Saving in freight on car load lots	
			25c rate	15c rate
Chestnut	43	7,700	$19.25	$11.55
Southern White Cedar	74	16,900	42.25	25.35
Northern White Cedar	91	12,800	32.00	19.20
Western Red Cedar	59	12,900	32.25	19.35
Western Yellow Pine	46	38,400	96.00	57.60

3. Under average conditions, the agencies of destruction of timbers are relatively as follows: wear, 5 per cent; breakage (overload) and fire, 20 per cent; decay (and insects), 50 per cent; all other causes, 25 per cent. Decay and insects are thus seen to be the greatest source of damage, and when attacked by either or both, timbers frequently are dangerously weakened and break in service. The danger from these causes being two and one-half times greater than from fire, their elimination may justify any reasonable cost of treatment.

4. Impregnation of timber with zinc chloride alone is one of the earliest and best known methods of timber preservation, but zinc chloride is not wholly resistent to fire and a number of mineral salts, such as aluminum phosphate and sulphate, ammonium chloride, ammonium phosphate and sulphate, sodium tungstate and boric acid have been used therewith as an aid in fireproofing.

Owing to the fact that the spores of the fungi (merulius lacrymans) or "dry rot" thrive in the presence of ammonia or its compounds, and cannot germinate without a certain amount of moisture, it is not advisable to use any salt containing ammonia or one which is highly hydroscopic. Moreover, ammonium phosphate, in addition to its high cost (11 cents per pound) is adaptable only to a high pressure process for thorough impregnation; ammonium chloride is exceedingly hydroscopic, and im-

parts the same property to the treated wood. These characteristics would seem to render the use of ammonia inadvisable.

The sodium tungstate is a good fireproofer, but its use is also limited because of its high cost. Boric acid forms white crystals over the wood, during the process of impregnation, around the steam coils and thermometer bulbs, thereby preventing accurate determination of temperatures; otherwise it is an efficient preservative from fire.

5. Aluminum sulphate, $Al_2(SO_4)_3$, known commercially as "white sulphate of alumina," is recommended by many, for use both as a preservative and fireproofing, due to its heat resisting qualities, and its low cost of two cents per pound. This salt, when used in fireproofing, should be neutral, (neither acid or basic), free from salts of sodium and potassium, and should not contain more than one per cent of iron; also, it should be granular and crushed to 40 mesh or finer. In the presence of zinc chloride and free from alkali, aluminum hydrate will not precipitate in the tank solution, especially where a one per cent solution of aluminum sulphate is used. The relative solubility of 1 part aluminum sulphate in 100 parts of water at different temperatures is as follows:

Cent.	$Al_2(SO_4)_3$	Cent.	$Al_2(SO)_3$	Cent.	$Al_2(SO_4)_3$
Degrees	Per cent	Degrees	Per cent	Degrees	Per cent
0	31.3	40	45.7	80	73.1
10	33.5	50	52.1	90	80.8
20	36.1	60	59.1	100	89.1
30	40.4	70	66.2		

The strength of aluminum sulphate in solution can be quickly ascertained from the specific gravity of the solution as shown by the following table:

Per cent	Spec. Grav. 25° Cent.	Spec. Grav. 35° Cent.	45° Cent. Spec. Grav.
5	1.0503	1.0450	1.0356
10	1.1022	1.0960	1.0850
15	1.1522	1.1460	1.1346
20	1.2004	1.1920	1.1801
25	1.2483	1.2407	1.2291

6. Zinc chloride as a wood preservative should be free from oxychlorides and other impurities, should be neutral and not con-

tain more than one per cent of iron nor less than 96 per cent of fused chloride of zinc. Zinc chloride is soluble in clean cold water, and is suitable for use in open tank treatment of timber. The commercial form of fused chloride "butter of zinc" is a transparent white mass, specific gravity 2.75, very hydroscopic, soluble in alcohol, melting at 100 deg. Cent., and distilling at a low red heat. It is a powerful caustic, drawing water from organic substances and carbonizing the wood, and in concentrated solution, will parchmentize paper. It is also a germicide, killing insects and the spores of dry rot. The purity of the salt, either fused or crystalline, can be determined by testing for free acid, solubility and specific gravity, using Kramer's table, as follows:

Solution Per cent	Spec. Grav. of Solution (cold)	Solution Per cent	Spec. Grav. of Solution (cold)
5	1.045	35	1,352
10	1.091	40	1.420
15	1.137	45	1.488
20	1.187	50	1.566
25	1.238	55	1.650
30	1.291	60	1.740

7. The chemical composition of different woods has been under investigation for many years, but as yet is little understood. It is claimed by some that when treated with zinc chloride a part of the salt enters into and forms a permanent combination with the cellulose of the wood. This, however, is doubtful, especially where weak solutions are used; the crystallization of the salts in the fibrous interstices of the wood cell walls is a more reasonable explanation.

8. The open tank treatment with zinc chloride consists of a hot bath followed by a cooling treatment, in which atmospheric pressure alone is used to obtain results that are quickly accomplished by artificial pressure in the closed cylinder process of other methods. The solution is heated in the open tank to 190° to 200° Fahr. Higher temperatures, as has been stated, cause warping, and the quick formation of insoluble zinc rosinates, etc., which hinder exudation from the wood cells and prevent thorough impregnation. Different temperatures should be tried with different woods to determine the maximum which will not cause warping.

The hot treatment should last fully 3 hours and be followed by immersion in a cold solution for 1 hour during which time

the wood cells contract and retain the impregnated solution. If not economical or practical to use a second cold bath, the wood should remain in pickle over night, so that the original solution will be thoroughly cooled. The attendants ("picklers") should be specially cautioned against immersing dry timber in a cold zinc chloride solution. The oxychlorides of zinc which form in a cold solution are inert as a germicide or preservative. Experiments indicate that the degree of impregnation of pine timbers of the same degree of dryness can be regulated by varying the temperature of the cooling bath.

9. To secure the maximum effective penetration the wood must be thoroughly seasoned before treatment with zinc chloride. Seasoned timbers have been treated very effectively by the open tank process, but green timbers only fairly so. Four years after the treatment of seasoned timbers no decay was found, while 13 per cent of green timbers similarly treated showed signs of decay. The open tank process is best suited to the treatment of cypress, unseasoned or partly unseasoned loblolly and Pennsylvania pines, and of seasoned Western pines. Before treatment, all timber should be cut and framed to final form and dimensions, as sawing, cutting and boring are likely to expose the untreated wood to attack by destroying organisms. Timber should be wholly immersed throughout the treatment and thereafter should be dried where completely shielded from the sun.

10. The open tank may be an old boiler shell or a rectangular tank equipped with steam coils or with a hearth beneath. A derrick or gin pole with tackle is needed for handling heavy timbers.

A steel tank, 3′x3′x33′ of 1/4″ plates, capacity 1,500 gallons, is used at the United States Boat Yard at St. Louis, Missouri. The tank is heated by four lengths of 1½″ steam pipe laid inside along the bottom. A thermometer is installed at each end. The total cost of the tank was only $275.00.

11. The variables entering into the open tank process, subject to future and more extended investigations are:

(a) duration and times of immersion in hot and cold bath,
(b) temperature of hot bath,
(c) strength of solution required for each kind of wood,
(d) the degree of impregnation probable for each kind of wood,

The following table shows the absorption of poles cooled over night, for timber cut at different periods of the year:

Time of Cutting	Wt. per cu. ft. before treating	Poles averaged	Duration of Treatment		Av. absorption per pole
			Hot bath	Cooling	
	Lbs.	Lbs.	Hours	Hours	Lbs.
Spring	22½	8	5	Overnight	61.5
Winter	24	20	6	Overnight	62.0
Summer	28	90	4-7	Overnight	45.0

12. The method of open tank treatment is preferred for the following reasons:

(a) the elimination of steam, vacuum, and pressure features of the cylinder process, and of the expensive machinery necessary,

(b) the light and economical construction of the tank,

(c) The cost for maintenance is much less than for any other process,

(d) the small amount of labor required,

(e) in general, the low cost of tank treatment is well within reach of most boat builders, mine operators and engineering concerns requiring small plants.

13. In the use of zinc chloride for wood preservation it has been found that

(a) the solution is non-poisonous in handling,

(b) impregnated wood may be worked with tools, the same as ordinary wood,

(c) the treatment does not dis-color wood, and it will take varnish and paint,

(d) it is completely immune to "dry rot."

(e) timber so treated is suitable for furniture, buildings, paving and general railway purposes, interior work of boat building, but must not be used in submerged work, as running water is liable to leach out the preservative salts,

(f) too strong a solution of zinc chloride or aluminum sulphate makes the wood brashy, brittle and blue in color.

14. A 4 per cent solution, containing some scrap zinc to prevent oxidation of the contained salts is suggested for the strength of the initial solution. The specific gravity of a 4 per

cent solution is 1.037, and as one gallon water at 62.50 Fahr. weighs 8.33 lbs., the number of gallons of water per 100 lbs. of zinc chloride may be estimated as follows:

$$\frac{100}{1.037 \times 8.33 \times 0.04} = 300 \text{ gals., nearly.}$$

15. The absorption after a hot bath of two or three hours followed by cooling for 24 hours is about 18 pounds per cubic foot. Seasoned timber in cold solution alone has absorbed 12 pounds per cubic foot. In general, Western pines absorb 16 to 18 pounds of 3 per cent solution per cubic foot, and 12 to 14 pounds of 4 per cent solution. Chloride of zinc costs 4 to 5 cents per pound (1914) and with an impregnation of 0.3 to 0.5 lb. of this salt per cubic foot of timber or 25 lbs. to 40 lbs. per M ft. B. M., the cost of treatment by open tank process, including labor, will be $2 to $3 per M ft. B. M.

The following method of determing zinc chloride in samples of timber has been found very satisfactory not only locally, but is used by many tie treating plants and railroads. Three grammes of dry borings should be weighed into a 250 c. c. flask and three c. c. of concentrated sulphuric acid added. The flask should be gently heated on a sand bath or hot plate until the wood becomes thoroughly charred. A few drops of concentrated nitric acid should then be added; when brown fumes have disappeared, a few more drops should be added, and the addition continued, a few drops at a time (toward the last the amount should be increased) until the organic matter is destroyed. When this point is reached, the liquid will remain colorless on further heating. The flask should then be allowed to cool and the contents diluted with 100 c. c. of water (added carefully at first). As a rule, the residue in the flask will be completely dissolved, but if there should be a slight sediment, it may be disregarded. Ammonium hydroxide should be added until distinctly alkaline and allowed to cool. If there is a precipitate of iron hydroxide, or if there is any dissolved sediment in the flask, it should be filtered; if not, it should be poured into a 400 c. c. beaker, 5 c. c. of ammonium sulphide added and allowed to stand over night. It should be then filtered into an 11 c. m. filter paper, washed thoroughly with water containing ammonium sulphide, and dried. It should then be incinerated in a porcelain crucible, and roasted until the zinc chloride is converted into zinc oxide. The weight should be divided by 3 and the result multiplied by 1.674, which will give

the number of grammes of zinc chloride contained in one gram of the wood, or the number of pounds per pound of wood. To convert this result into pounds of zinc chloride per cubic foot of wood, multiply by the weight in pounds of one cubic foot of the wood.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

THE LOCAL ENGINEERING SOCIETY.

Discussion by Members of the Engineers' Club of St. Louis.

(Volume 53, page 64, August, 1914.)

Mr. E. R. Fish. The author's remarks indicate that he is having the same old problems that have burdened most organizations since there were any such. Everyone knows that much thought has been expended and innumerable schemes evolved in endeavors to bring up the average attendance at meetings and interest in the management of associations of all sorts and that most of such attempts have resulted in no permanent improvement. Our own Engineers' Club has been no exception in many particulars, but the fact that our membership has continued to increase with comparatively few withdrawals indicates that the members at large feel that the Club fills a need, to the maintenence of which they are willing to contribute financially, if not by personal attendance and effort. It is confessedly true of practically all organizations that the policies and management are dictated by the comparative few who happen at the time to be particularly interested, but the personnel of these few is constantly shifting so that in the long run, therefore, policies change and a considerable number share in the work.

Any association that persists over a long period must almost inevitably be of some use or the judgment of its members would not be justified. In these times of complicated living nearly everyone has numerous interests and belongs to several organizations, in a few of which he is specially interested. It is to be expected and not surprising that the attendance at our meetings, is comparatively small,* but I do not regard that as evidence of failure of purpose, influence, or lack of need of the Club.

As a side glance, attention is directed to the fact that if a large percentage of our members attended regularly, our income would not be sufficient to provide accommodations for them, and a general readjustment of methods would be forced upon us.

That the efforts of those entrusted with the management, and that the policies decided on by the few are backed up by the membership at large, evidenced by their continued membership, or in whatever other way it may be, assures me that our Club has filled a need and shall continue to do so. A recent revision of

*(The average attendance last year was 74. Not so bad!—Ed.)

our constitution specifically provides for the broadening of the Club's sphere of action and on several past occasions I have taken opportunity to urge that we should take more part in the settlement of municipal problems. The design, installation and maintenance of the physical part of any municipality, large or small, are largely of an engineering nature and serious attention on the part of a Club such as ours to questions of public importance must be of value to the community and to our own members. Such service calls for more or less sacrifice and inconvenience to the individuals who, on committees or otherwise, bear the burden of efforts of this kind. But properly divided up, the weight on each will not be great for the selections can be made from among large numbers. Consistent and intelligent effort and conscientious avoidance of any partisan or biased positions will eventually result in our judgment and recommendations being regarded as authoritive and to be relied upon. In this path I believe lies our greatest usefulness. Our success as an organization would not then be unmeasured by comparative records of attendance, but rather by the extent to which our suggestions and recommendations might be accepted. I wish to reiterate that small attendance at meetings and apparent indifference is not necessarily evidence of failure of purpose, so long as a growing and persistent membership roll can be pointed to as evidence of the support of at least a considerable proportion of those of the community eligible for membership.

Mr. W. W. Horner. Mr. Stanley's paper is written in a happy mood; it is a boost for the society and at once a spanking and a cajoling of the inactive and inert majority of the membership as individuals.

The Engineer's Club of St. Louis possesses the same majority but fortunately, our minority is so active that I believe to an outsider the whole mass actually appears to move. We have also been fortunate in having gone through several spirited and almost sanguinary fights where the noise of the disturbance was so great that those on the outskirts woke up and asked what it was about. I believe that even more than our get-together slogan, our differences of opinion have served to verify our membership and, in fact, our differences have all been over the methods to be adopted in serving the membership. Our object is stated to be the professional improvement of our members and the advancement of engineering.

Mr. Schuyler thinks our membership would be better off for a good feed and a moderate allowance of beer. Mr. Woermann would stiffen the backs through compulsory reading of the Journal. As secretary, I can heartily commend the Journal, but as a member I prefer the beer.

Mr. Stanley, in his enumeration of the advantages of the local engineering society, emphasizes five points:

The library.

The journal.

The reading of papers.

The acquaintance of other engineers, and the development of the social side of character, self-advertisement among engineers and through the strong society, advertisement of the profession, which he illustrates by the service rendered to civic and municipal bodies.

Taking Mr. Stanley's points in order, I believe that several of our members have made good use of the library. The library has been neglected, and aside from its inaccessibility, over which we have often argued and will continue to argue, it is also incomplete. Including many of the older works and reports of great value, and with an exceptional periodical list, it yet lacks the last word in almost every line of engineering. I believe this year we should either decide to put it where it can be combined with the later works or that we should spend a large amount of money to bring it up to date.

The management of the Journal is to be greatly commended for the work done so far, but I think the profession could be equally well served by the publication of the same material in other mediums, and the energy now expended on the Journal would be available in other directions.

To me, as a member, the society has been of greatest value through broadening influence of intercourse with other engineers, both at the meetings and in the work of the organization, and in addition, I believe I have gleaned more miscellaneous engineering information outside of my own line from general discussion during committee meetings than I have from the technical papers.

My advice to a man who wishes to get the full value out of his membership would be to volunteer to serve on a committee.

Mr. A. P. Greensfelder. Secretary Stanley's paper in the August issue of the Journal shows that at least one Oregon en-

gineer is not only alert and broad in his profession, but also earnest in his endeavor to do something for his professional club in which he takes just pride. It should be evidence of good will towards his brethren when a far-sighted and outspoken leader is willing to impress upon his neighbors their duties towards an organization whose sole object is to better their condition.

A local club is to its community what a national society is to the country, with the added important feature of frequent personal contact which is equally as important as technical papers. As a place to forget one's troubles by listening to the other fellow, its effect is more stimulating than a turkish bath and more shoulder-bracing than a football game. An engineers' club discussion in full blast, with parry and retort has a moving picture show backed off the "boards," and a cabaret nailed to a standstill! The only objection is its rarity, but by way of instilling its greater frequency a little Franco-Prussian ginger may be recommended as a lubricator.

That the troubles of this particular secretary are neither new, peculiar to his region, or likely to be immediately solved, we may refer to Benjamin Franklin's own Junto Club in Philadelphia a century and a half ago. Some of the 14 formal questions they read aloud at each meeting might be of interest at this time and place:

"1. Do you know of a fellow-citizen who has lately done a worthy action deserving praise and imitation; or who has lately committed an error proper for us to be warned against and avoided?

"2. Do you think of anything at present in which the members of the Junto may be serviceable to mankind, to their country, to their friends or to themselves?

"3. Hath any deserving stranger arrived in town since last meeting? And whether, think you, it lies in the power of the Junto to oblige him or encourage him as he deserves?

"4. Do you know of any deserving young beginner lately set up, whom it lies in the power of the Junto in any way to encourage?

"5. Have you lately observed any defect in the laws of your land, or do you know of any beneficial law that is wanting?

"6. In what manner can the Junto or any of its members assist you in any of your honorable designs?

"7. Have you any weighty affairs on hand in which you think the advice of the Junto may be of service?"

Insert the words Engineers' Club in lieu of Junto and interpolate a few modern technical terms and you have our modern problem as clearly stated now as then.

The good red blood of our ancestors was no more sturdy than our own, their "Rules of Reason," no more sincere and their principles no more vital than ours.

The initiative spirit, the willingness of some to do more than their share, the elimination of jealous or callous feelings, can with united effort do more, go farther, and faster to-day than then.

Franklin's Junto Club evolved into the parent Public Library Association of our land. We can foresee the untold possibilities of modern engineers united in common effort for the betterment of themselves and their community?

[NOTE—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

ASSOCIATION
OF
ENGINEERING SOCIETIES

Vol. 53. OCTOBER, 1914. No. 4

PROCEEDINGS.

Montana Society of Engineers.

Butte, Mont., May 11, 1914.

The regular meeting of the Society met at the regular hour, President Sales in the chair. Members present, Bacorn, McArthur, Moore, Sales, Simons. Minutes of the last annual meeting approved as read. The application of George Eugene Baker for membership was read, approved and ballot ordered. Messrs. Eastman, Lange, Idle and Macdonald were elected to active membership in the Society. Willis T. Burns was appointed a member of the Good Roads Committee vice Archer E. Wheeler, resigned. Messrs. Bacorn, Simons and McArthur were named an Advisory Committee to the President with reference to determining the place for holding the next annual meeting. The Secretary was instructed to call the attention of Mr. Eugene Locke to the By-Laws of the Society regarding yearly dues and to return his check. Communications from Senators Myers and Walsh, Congressmen Evans and Stout by the Secretary approving of a measure to revise our mining laws. A communication from the Technical League of United States was ordered filed. Announcement was made of the appointment of Mr. James A. Barr as director of Congresses of the Panama Exposition. At the request of the Secretary the use of the Society Room was granted to the officers of the Inter-Mountain Good Roads Annual Meeting in July. Adjournment.

Clinton H. Moore, *Secretary*.

Civil Engineers Society of St. Paul

St. Paul, Minn., May 11, 1914.

The regular monthly meeting of the Civil Engineers' Society of St. Paul was called to order by Vice-President Meyer in the absence of President Toltz, in the Council Chamber at the City Hall at 8:30 p. m., May 11th. Mr. Meyer then turned the chair over to Treasurer Brink.

There were 16 members and 8 guests present.

Minutes of the last meeting of the Society were read and approved.

Moved and seconded, that the regular weekly noon-day luncheons of the Society be continued during the summer months. Discussed. Vote, Yea 6, Nay 10. Motion lost. The regular weekly noon-day luncheons of the Society will therefore be discontinued until further action is taken.

Entertainment Committee Chairman Rathjens outlined several prospective summer excursions for the Society, among which a trip of inspection to the Stillwater State Prison was prominently mentioned. General discussion with suggestions followed.

Moved, seconded, and carried, that the Secretary cast the unanimous ballot of the Society for the election of the following applicants to full membership in the Society, all approved by the Examining Board:

Gates A. Johnson, Sr., 506 East 14th St., Brooklyn, N. Y.
Louis Knudsen, Brainerd, Minn.
Harry B. Roe, 2105 Scudder Ave., St. Paul, Minn.
Allan Seymour, 2547 Blaisdell Ave., Minneapolis, Minn.
And for Junior Membership, Oswald Lind, Warren, Minn.

Four applications for membership were received and were referred to the Examining Board.

Adolph F. Meyer, Consulting Engineer, then gave an informal talk on "Estimating Stream Flow from Rainfall Records," illustrated by lantern slides showing diagrammatically various records and phenomena upon which he based his conclusions.

Motion to adjourn, seconded, and carried, at 9:55 p. m.

Minutes of meeting reported by

WM. U. CAREY, *Member,*
in the absence of
EDW. J. DUGAN, *Secretary.*

The Engineers' Club of St. Louis.

The 776th meeting of the Club was held on Saturday, August 29, 1914, as a trip of inspection. There were in attendance 75 members and guests. After meeting at the east entrance to the City Hall, the party proceeded to visit and inspect the following works, which were all in the process of construction: The New City Jail, Twelfth Street, Jefferson Avenue and Tower Grove Viaducts and the reinforced concrete greenhouses, power plant and Natural Fernery at Shaw's Garden.

All of these works are of the most improved design and the methods of construction employed at each the very latest. The trip proved of exceptional interest to all in attendance.

Private transportation was furnished by the United Railways Company through the courtesy of Messrs. Richard McColloch and Bruce Cameron.

Messrs. W. E. Rolfe, L. R. Bowen, W. Haydock, P. Topping, S. M. Bate and Dr. George Moore served as guides at the several places of inspection.

Adjourned, 5:30 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

The 777th meeting of the Club was held in the Club Rooms, Wednesday, September 9, 1914, at 8:30 p. m., as a re-union or experience meeting, being the first regular meeting following the vacation period. President Greensfelder called the meeting to order and then called upon Mr. W. E. Rolfe, Chairman of the Entertainment Committee, to preside. The total attendance was 85.

Mr. Herman Spoehrer spoke on the coming Convention of the League of Electrical Interests, to be held in St. Louis, October 14, 15 and 16, under the auspices of the Jovian Chapter, soliciting the co-operation of the members of the Engineers' Club in welcoming the members of that organization to St. Louis.

Messrs. W. W. Horner, E. R. Fish and H. J. Pfeifer spoke on the topic of "The Local Engineering Society" with reference to a paper appearing in the August issue of the JOURNAL. The Assistant Secretary read anomymous letter bearing on this subject.

Mr. Julius Pitzman, recently returned from Europe, related his experience while in Europe and on his return subsequent to the declarations of war by several of the European powers.

Messrs. J. A. Ockerson and J. W. Woermann told us about the A. S. C. E. Convention; Mr. F. E. Bausch, about the A. S. M. E. Convention, and Mr. F. J. Bullivant about the A. I. E. E. Convention.

Refreshments were served and the meeting adjourned about 11:30 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

The 778th meeting of the Club was held in the Club Rooms, Wednesday, September 16, 1914, at 8:30 p. m. Second Vice-President E. D. Smith presided. There were present 28 members and 5 visitors.

The minutes of the 773rd, 774th, 775th, 776th and 777th meeting of the Club were read and approved. The minutes of the 551st, 552nd, 553rd and 554th meetings of the Executive Committee were read.

Motion made, seconded and carried that the Assistant Secretary write a letter to the United Railways Company expressing thanks and appreciation of the courtesy extended to the Club in furnishing private cars for transportation to the several places visited on our trip of inspection, August 29, 1914.

The presiding officer presented Mr. William H. Reeves, President of the Reeves & Skinner Machinery Company, who read a paper entitled "Machinery Salesmanship." Discussion followed, participated in by

Messrs. A. S Langsdorf, H. H. Humphrey, W. A. Hoffman, F. L. Wilcox, Ramsay Skinner, A. P. Greensfelder, J. W. Woermann and F. J. Bullivant.

Adjourned 10:00 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

The 779th meeting of the Club was held in the Club Rooms, Wednesday, September 23, 1914, at 8:15 p. m. President A. P. Greensfelder presided. There were present 40 members and 6 visitors.

The minutes of the 778th meeting of the Club were read and approved.

The Assistant Secretary read a letter from H. H. Humphrey presenting to the Club Annual Reports of the Board of Water Supply of the City of New York. Motion made, seconded and carried that letters of thanks be sent to Mr. Humphrey.

The presiding officer presented Mr. Henri Rusch, Chief Engineer, Building Department, City of St. Louis, who read a paper entitled "Building Laws." The paper principally dealt with the proposed revision of the building laws of the City of St. Louis. Mr. Rusch solicited the cooperation of the Club, through its committees, to lend its aid in perfecting the building code.

Discussion followed participated in by the following members and guests: A. A. Aegerter, H. C. Henley, Carl Gayler, R. G. Alexander, T. E. Morrison, J. A. Whitlow, J. W. Woermann, E. R. Fish and S. E. Swingley.

Adjourned 10:15 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

The 780th meeting of the Club was held in the Club Rooms, Wednesday, September 30, 1914, at 8:15 p. m. President A. P. Greensfelder called the meeting to order. There were present 97 members and 18 visitors.

The minutes of the 779th meeting of the Club were read and approved.

The Assistant Secretary read a letter from the Association of Engineering Societies offering for amendment Article V, Section 1, of the Articles of Association of the Association of Engineering Societies. Motion made, seconded and unanimously carried that the Engineers' Club of St. Louis is in favor of the proposed amendment which reads as follows:

ARTICLE V.

> Section 1. Any Society of Engineers or other organization, may become a member of this Association upon the adoption of these Articles by a majority vote of said society and the approval of such affiliation by a majority of the Board of Managers.

Mr. H. A. Wheeler addressed the Club on behalf of the St. Louis Section of the American Institute of Mining Engineers inviting the mem-

bers of the Club to accompany that organization on a trip of inspection through the lead belt of Missouri on October 2 and 3, 1914.

President Greensfelder then called upon Mr. Robert Moore to preside.

The program of the evening was entitled "100 Minutes with Great Men and Their Problems." Members of the Board of Public Service of the City of St. Louis were guests of the evening. The entire Board, consisting of Messrs. E. R. Kinsey, C. M. Talbert, J. A. Hooke, C. E. Swingley and Emil Tolkacz, were present. The presiding officer called upon speakers of the evening in the following order: Edward Flad, C. M. Talbert, J. H. Kinealy, C. E. Swingley, M. L. Holman, J. A. Hooke, A. S. Langsdorf, Emil Tolkacz, W. S. Mitchell and E. R. Kinsey. The talks were mainly in reference to the New City Charter, civic betterment and a greater activity for the Engineers' Club.

A rising vote of thanks offered to the speakers of the evening.

Adjourned 11:00 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

ASSOCIATION
ENGINEERING SOCIETIES

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Vol. 53. NOVEMBER, 1914. No. 5

MACHINERY SALESMANSHIP.

BY WILLIAM H. REEVES.*
MEMBER OF THE ENGINEERS' CLUB OF ST. LOUIS.

[Read before the Club, September 16, 1914.]

Salesmanship is about the most difficult subject to discuss that I can readily call to mind. Little seems to be known about it. The selling problems must be worked out in each individual case. No definite rules or laws can be developed and established which can be reliably employed over a wide range of activities. A rule will succeed in one instance and fail in another. The whole subject is still in a state of darkness and doubt, and from its very nature must always remain so. At best, only a few generalities, that is, broad matters of policy, can be formulated and enforced.

Salesmanship, that is, the feat of selling, is the beginning and very foundation of all business, for without the sale having first been made there can be no other business functions to be performed. Other things than making sales are essential to success, but without sales, success is not possible.

It takes two to make a bargain, a buyer and a seller, and each negotiation represents both a purchase and a sale. A purchase and a sale are identical, the only difference being in the view point. Buying is the positive, and selling the negative side of a transaction. Since the seller must take the negative role,

*President of the Reeves & Skinner Machinery Co.

his success or failure is contingent upon what the buyer may do, rather than upon any action of his own. It will be seen that a salesman can go just so far. By that is meant that when he has to the best of his ability exhausted all his resources in presenting features and considerations that might be an inducement to the buyer, he is done, and can then only await the decision of the purchaser.

Selling methods must vary widely according to the thing to be sold and the conditions under which sales have to be made. Some lines depend upon aggressive salesmanship to the extent the salesman must almost without exception sell the buyer something he did not know he wanted. Life insurance occurs to me as an example. Some years ago, I entered the office of an agency manager of one of the well-known life insurance companies, introduced myself and announced that I desired to make application for a policy. He became confused and knew not how to proceed. He soon became suspicious. Finally he composed himself and decided to make a clean breast of his perplexity, and asked me to tell him frankly how I happened to come in voluntarily and ask for insurance. Not until I had explained that a mutual friend had exacted a promise from me to take out some insurance with him did he produce an application blank to be filled out. We afterwards became warm friends, and one day he confided to me that during his many years experience he had not had another voluntary application case to come to his notice.

The considerations from the buyer's point of view are so numerous and varied that the selling details should be more or less flexible. There are, of course, exceptional industries in which practically every detail of the negotiations can be worked out in advance, and every transaction reduced to a standard printed form, including established prices and unform terms of payment. As an illustration, I have automobiles in mind. The present demand is so enormous that any manufacturer can sell a tremendous output with only two or three models of approximately the same class, without catering to the individual notions of the customers, as to construction details, prices and the manner in which payment is to be made. If the salesman cannot convince the buyer the standard product at the established price and on the regular terms of payment is best for his

particular needs, the manufacturer can better afford to lose the sale than to make even trivial concessions. Why should the manufacturer permit the standard printed contracts to be mutilated when the entire factory output can be sold without it?

In every selling campaign the matter of advertising is an ever present problem. There is always the temptation to try to "get rich quick" by the advertising route. This is just as true of legitimate enterprises as it is of the illegal ventures. Reaching buyers by advertisements at several thousand dollars per issue is like making sales by long distance telephone, both being too expensive for general adoption. If an article is advertised extensively, it is a safe assumption the advertiser is either losing money or making more than a customary percentage of profit.

After advertising has been chosen as an important feature of the proposed attack, then arise the most difficult problems of all to solve. Much ingenuity must be employed in preparing the first "copy," to compel the attention of the reading public. For the succeeding series, the task becomes gradually harder, for it is most difficult to retain interest that has already been aroused. Interest of this character is scarcely more than curiosity and wanes rapidly with familiarity. We have all seen pedestrians congregate and block the sidewalk in front of a show window the first day some freak novelty was put on display, and noticed the crowd become smaller each day for, say a week, and then disappear. Curiosity, or interest as some may prefer to call it, had dwindled to practically nothing in a few days, and the display had run its course as a useful advertising medium, and it is just so with newspaper, periodical and bill-board advertisements.

If the article to be sold is a specialty, which can be sold at several times its production cost, for which every person is a prospective customer—tooth powder for example—the selling should logically be done chiefly by advertising. Every paper, publication, program and bill-board having a circulation should be used. The advertising creates the demand and the so-called salesmen simply call on the dealers and take the voluntary orders, or if a salesman does not call in time, the orders will be mailed. In such cases, the salesmen do not have to discuss the merits of the goods they are selling, and do not have to care

whether the articles have any merit. In this case, the actual salesmanship occurs in preparing the advertising matter and distributing same in the most effective channels.

As the number of possible customers becomes less in proportion to the total population, or as they become classified, keener discretion must be exercised in selecting publications to be used. One illustration may suffice. It would, undoubtedly, be a waste of money to advertise safety razors in publications for women.

In getting away from commodities for personal use, the selling becomes harder and more complicated. The flashy and sometimes impudent "Ads" with which we are all familiar, cease to be effective. Also as the proportion of the population who might become purchasers is reduced, the effectiveness of advertising is lessened.

Without giving the exact ratio very serious consideration, I hazard the suggestion that not to exceed one out of each five thousand population has ever, or will ever, employ a consulting engineer. Higher motives may be attributed to the general advertising restraint among consulting engineers, but the real reason is, advertising for them is unprofitable. The employers of consulting engineers being so few in number and so widely scattered through the many industrials it is not possible to reach many prospective clients through any single trade publication. Not much can be expected from the engineering papers because their chief circulation is among engineers, the advertiser's competitors. I doubt if any professional engineer present can say his clientele is to any great extent composed of regular subscribers to the engineering papers.

The main subject for discussion on this occasion is the selling of apparatus and auxiliaries used for the production of power and for the utilization of power in doing useful work. In this line, competition is usually keen, and also there are a great many details to be worked out and agreed upon. It seems impossible to establish a fixed set of rules for taking care of the details, or to standardize a line of arguments. Each case must be handled according to circumstances and developments.

The work of the salesman would be simpler if there were any similiarity in the methods of purchasers. Some buyers are well informed concerning the apparatus to be purchased and in-

telligently and earnestly analyze all of the features worth considering and will take the initiative in obtaining concise data on the essentials, and will promptly make a sound selection. Such buyers are ideal and make the best customers. As a rule, they are willing to pay fair prices, believing it to be poor policy to attempt to buy a piece of machinery for less than it is worth. Many successful and substantial business men would not knowingly contract for work at a price that would not permit the contractor to do the best work he knows how to do. With such customers the salesman is warranted in submitting his best prices at the beginning and to give, without hesitation, any data the purchaser may require to intelligently consider his bid and to compare same with competitive tenders. The salesman can rest assured his candor will not be used to his disadvantage. Business men of the type we are now considering prefer to buy from salesmen who are prompt in submitting complete and accurate information.

Fortunately there are many buyers of the class just described among the producers and users of power. The remaining types of buyers are the ones who tax the salesman's resourcefulness and indirectly encourage sharp practice in making sales.

The chief obstacles with which salesmen must contend might be briefly summarized and commented upon as follows:

Ignorance—When the customer is partially or totally ignorant on the subject under discussion, there are several plans open to the salesman. If the buyer is conscientious and otherwise dependable, the salesman might endeavor to win his confidence to the extent the customer will seek his aid and advice as to the character and details of the equipment to be used, or in other words, to grant the salesman the privilege of preparing his own specification for the other bidders to follow. If this much can be accomplished, the salesman has at least insured fair bidding, that is, all bidders working from the same specifications, and the salesman has probably secured a little advantage over his competitors for two reasons, first; it might be possible to prepare the specifications so as to eliminate inferior apparatus, and second; the customer might feel under some obligation and give him a slight preference in case of a close decision. If the course just outlined is not practicable, the salesman must then choose between offering the equipment he feels would best meet

the customer's needs, knowing his bid will be high, or to offer the cheapest apparatus at his disposal, hoping to catch the customer with a low price, or if he cannot get any clew as to which would be the better plan, he might submit several alternate bids just on the theory that each proposal is a chance and consequently the more proposals he makes, the more chances he will have.

Procrastination and Indecision—Some purchasers have the exasperating habit of putting off their decision from day to day. In the meantime, the competing salesmen are obtaining by strategy and by other means, information concerning each others proposals, and by their combined, but not united, efforts, get the customer more and more confused. The purchaser sees good and bad points in all proposals submitted. To-day he leans one way, and to-morrow, another way, and so on, according to which salesman he has seen last. The customer is probably asserting that he wants to be perfectly fair with everybody, and if one salesman scores a point, he will, undoubtedly, in carrying out his false notion of fairness, tell all the competing salesmen with the idea of giving them an opportunity of doing the same thing. The other salesmen knowing where the thing originated, and knowing it was favorably received, are unanimous in their criticisms, and the chances are collectively they will talk the customer out of it, and some of them will suggest something entirely different. Each salesman is submitting something new each day. The confusion continues until everybody, including the customer, becomes completely exhausted. At this stage the procrastinating and affable customer is apt to announce that he will postpone the matter for a few days, and still wishing to be absolutely fair with everybody, he faithfully promises to advise each and every one of the salesmen when he is again ready to take up the question, so they may have the opportunity of returning, if they choose to do so. The disheartened lot of salesmen, confidently expecting to be notified when to return, leave the job, but as a general thing, there is one salesman who knows the possibilities better than the purchaser himself, who remains under cover until the following day, and returns to the job and gets the order. The purchaser is pleased to have so easily gotten out of his dilemma.

Prejudice.—Practically all buyers begin a negotiation with some degree of prejudice with regard to the bidders. This

might be based upon a dislike of one or more of the salesmen, or an unfavorable opinion of the firms they represent, or a lack of familiarity of their products. It might also be due to a preference for some particular make of apparatus, or to friendship for, and special confidence in, one of the bidders. It is almost impossible for the purchaser to be absolutely neutral and indifferent as to who will or who will not secure the award. Prejudices and preferences are very important features when dealing with the better class of machinery purchasers and as the work becomes larger and more important, the more important these influences become. This is sound business and perfectly legitimate when based upon direct or indirect experience or knowledge. If this were not true, what incentive would there be for a manufacturer or a contractor to do superior work at extra cost, or to put it differently, why should one worry about his reputation?

Erroneous Ideas and Hobbies.—These are hard to combat. If they are unimportant and the features insisted upon will not prejudice the performance of the equipment, it is better salesmanship to let the customer have his way than to risk an argument, but if the carrying out of such schemes would be detrimental to an appreciable degree, or if they are impracticable, it becomes the duty of the salesman to undertake to change the customer's view. A direct attack is too hazardous and should be used only as a last resort. Some indirect discussion tending to enlighten the customer generally, and enabling him to approach the subject from a new and correct viewpoint, might be effective in that he may discover his own mistake. It is better to give the customer credit for correcting such an error than to try to force an admission from him that he was wrong.

Dishonesty.—This is not encountered frequently, but often enough to justify a salesman in being on the lookout. With a buyer who is spending his own money, dishonesty is limited to the making of false statements as to competitive prices and details with the intention of securing concessions it would probably not be possible to obtain by honest means. In the case of buyers spending other people's money, and with subordinates upon whom the principal is depending for advice, another form of dishonesty is possible, namely, the demanding of gratuities. Fortunately, these cases do not come up often enough that one's success or failure depends to any appreciable extent upon

whether he does or does not participate in negotiations of this character. It would be useless to give any advice on this subject because everyone knows right from wrong, and consequently no one needs assistance in determining the right and moral course to follow. The question of morality in business hardly comes within the scope of this discussion.

Trying to Get Something for Nothing.—As before stated, some buyers are willing to pay a fair price for good machinery, while others are not. Some purchasers will go to almost any extremity to work prices below the real worth of the goods. A few purchasers will not knowingly permit machinery manufacturers to make any money on their purchases. They positively will not buy until the last dollar has been shaken out of the transaction. It is not often that this class of business is secured by a good salesman, that is, a man who has his employer's interest at heart. Such buyers prey upon salesmen who are interested only in making sales and have no concern as to whether the firm they represent is financially benefited or not.

The classification and discussion of obstacles to be overcome by salesmen could be carried on to a great length. It is my hope that I have gone far enough into the subject to convey some slight idea of the vast array of problems confronting a salesman.

There is nothing mysterious about making sales. The salesman does not have to possess some subtle influence with which a buyer can be controlled. Plain horse sense is the best fundamental qualification a salesman can have. On top of this foundation he should be well informed in regard to his particular line of apparatus, the engineering and mechanical work employed in its production, and a correct knowledge of its functions as well as its limitations. He should at least be enough of an engineer to be of substantial assistance to his customers in the matter of making selections.

A salesman worth while should take pride in making each sale a satisfactory transaction to both the customer and his firm. To insure this, he must see to it that the best machine for the work has been selected, the price is fair to both parties, and leave no room for misunderstanding and dispute over engineering details, date of delivery, terms of payment, etc. It is his duty, as far as practicable, to secure sufficient data to enable his firm to begin and complete their work without being com-

pelled to ask the customer for additional information. More disputes between manufacturers and their customers are due to lack of precision and thoroughness on the part of the salesman than from any other cause. The responsibility for a large proportion of disagreements can be traced directly to the salesman.

Thus far we have considered only the work of the salesman. His work is only the culmination of salesmanship and not the source. Salesmanship, be it good or poor, begins with the chief executive of any firm, and wends its way through the institution, receiving a beneficial or detrimental contribution from each department. The sales department must be supported by the balance of the establishment. The selling department cannot permanently excel the other departments. If the balance of the institution cannot rise and keep pace with increasing sales, the sales cannot continue to increase. This is why many manufacturers get about so large and no larger. They remain about stationary for a number of years and finally begin to decline. Over-prosperity, due to the efficiency of the sales department, is often a source of danger. It is apt to create a false feeling of security all along the line, resulting in a general relaxation. Mistakes in engineering, blunders in shop production, delays in shipment and irregularities of other kinds are all excused on the ground of the crowded condition of the shops. The habit of overlooking mistakes is soon acquired and will soon reach such proportions that scarcely one order is handled in its entirety without some sort of an irregularity occurring, which the salesman will have to "smooth over" with his customer. The salesman can do this once or twice, but he cannot keep it up if the customer has some sort of a disappointment in connection with almost every contract. No sales organization or individual salesman can forge ahead with such poor support. A big share of the business is bound to go to a more worthy rival. When the overdue slack period does come, the work is not executed with any greater precision than before, proving that the crowded condition was merely the opportunity and not the direct cause of the lack of discipline which brought about the condition which made it harder for their salesmen to make sales to old customers than to new ones.

A salesman's success or failure is as much contingent upon the capabilities of the firm he represents as upon his own efforts, and therefore, there is a positive limitation to his achievements.

In closing, the point I wish to emphasize is, superior salesmanship is impossible without the aid and protection of superior service, such as can be rendered only by the exceptional manufacturer who enforces accuracy and punctuality in every department. A mere willingness to correct mistakes is inadequate.

DISCUSSION.

Professor A. S. Langsdorf. The subject of this evening's interesting paper is not very closely related to my own work, and accordingly, I did not expect to be called upon to contribute to the discussion. Nevertheless, the general subject of salesmanship is one that is of interest to teachers of technical subjects if for no other reason than that they are frequently called upon to handle students (and parents thereof) who labor under the delusion that education is a commodity to be handed over the counter in exchange for the tuition fee. Thus, whereas, the salesman must be able to prove to the customer that his goods are a fair exchange, or more than a fair exchange, for the contract price, the teacher must eventually prove to his students that the tuition fee bears no relation whatever to the class-room transactions, and that it is merely an acknowledgement of the student's privilege to take away as much information and training as he is able to acquire by his own efforts under watchful guidance.

I was much interested in Mr. Reeves' summary of the obstacles encountered by the salesman. They are so strikingly similar to those encountered by the teacher that they will bear repetition:

1. *Ignorance.* You will doubtless agree that this element is as frequently met with in the class room as in the market place.

2. *Procrastination and Indecision.* Of these, the former, familiarly known as loafing. is common until the advent of final examinations.

3. *Prejudice.* A great many students, particularly in technological courses, are violently opposed to being obliged to study subjects that are apparently dissociated from the pursuit of the dollar.

4. *Erroneous Ideas and Hobbies.* It is hardly necessary to point out that one of the chief functions of a teacher is to over-

come erroneous ideas, and that he is kept reasonably busy in fulfilling his mission.

5. *Dishonesty.* In the school or college this element gives rise to committees on discipline and student honor committees.

6. *Getting Something for Nothing.* This is quite common in the educational world, and usually takes the form of hunting "soft snaps."

I think that these items cover Mr. Reeves' list, at least as far as I was able to jot them down. I might add, as he did, that the list might be extended indefinitely.

I would like to add that the business of salesmanship is one that is more and more attracting young graduates of engineering schools, and that the schools are recognizing that field of work as a legitimate outlet for their product. In the past, and even up to and including the present, evidence has not been lacking that graduates of highly specialized technical courses have looked with more or less disdain upon the commercial features of engineering, in the belief that scientific attainments were of overshadowing importance. Usually a year of two of practical experience suffices to establish a saner view and a clearer perception of the intimate relation between technical engineering and business methods and economic conditions. The schools are attempting to meet this situation by incorporating in their curricula as much of the principles of economics as can be crowded into an already crowded course of study.

Mr. H. H. Humphrey. Mr. Reeves spoke of the prejudice which the salesman goes up against in selling machinery or, in fact, selling anything else. I believe there is an old saying, "Let the buyer beware." Whether there is any foundation for that in the present days or not, I will not say, but it is evident that there is some prejudice that the salesman goes up against, and that is where the personality of the salesman comes in. Anybody that has had experience in buying machinery knows it is much easier to deal with a friend or a man with a pleasant personality than with one that is entirely the opposite. If the salesman approaches the buyer with the idea that he is going to tell him all about it, and all that he doesn't know, he gives an impression that is quite different from one that leads the buyer on to see all his good points, and giving the buyer the impression all the time that he knew it all in advance; so that personality goes into it very strongly.

I am reminded of a former member of the Club who was a close personal friend of mine—a salesman of electrical machinery. He always disposed of that prejudice very nicely. He said, "I will get you this machinery." He took the side of the purchaser. He said, "Now leave it to me—I will get this machinery and I will get a price that is right," and it made a very pleasant impression. He, in fact, was one of the most successful machinery salesman the City of St. Louis has seen. I think it was largely due to his personality and his attitude in taking the purchaser's side—the purchaser's viewpoint and helping the purchaser out.

Mr. F. L. Wilcox. There is one point that Mr. Reeves emphasized to some extent that I wish to emphasize again, and that is the point of service. I have known contractors to say, time and time again, that the reason they wish to buy from a certain firm is the service they get. They tell you when they are making up their bids on a job that if they go to a certain firm they get a bid that will cover everything in the power house, and there won't be any "ghosts," while with other firms there is something left out—an extra. That is service.

There is one other point that Mr. Reeves did not mention that occurs to me, and that is the matter of patience. Sometimes a salesman gets an idea, especially with people he is not very well acquainted with, that if he cannot sell a job, or if two or three jobs go against him, there must be something wrong. He lacks patience. He is never willing to admit that the other fellow is the better salesman. I have had that occur in my own experience. Last year, I had a salesman come in and intimate very strongly that he was not getting a square deal because he could not sell the job. Salesmen, I think, are too liable to jump at a conclusion and they miss an opportunity when they start to do business with people for the first time, by not having patience.

Mr. E. D. Smith. I think the question of service is one on which we cannot put too much emphasis. Not long ago, in connection with a contract in which we were interested, and immediately after the contract had been awarded, a salesman made the remark (an unsuccessful salesman he happened to be) that he was glad *he* was not a contractor; that when the contract was awarded the contractor's troubles had only begun, but that when a salesman closed the contract his troubles were over. I

think perhaps too many salesmen look at this matter from the same viewpoint as the salesman above referred to, with the result that orders should be repeat orders for them very probably go to the other fellow.

Mr. A. P. Greensfelder. This subject is a little out of my line. I have always had a vast respect for a salesman, because, as a rule, they are experts in their particular fields. No matter how thoroughly you may imagine you know what you want, those salesmen who have made a life-long study of the things they are selling can usually give valuable ideas. I have yet to find a man who cannot give you a good many points that you have never thought of, although scant attention is too often given the man. He gets up a set of plans for you, and when he calls you do not happen to be in the humor, and you throw them on your desk, saying, I will look them over, and then do not give them any consideration. As a matter of fact, he has gone to a great deal of trouble, and I think it is time well spent to give him a hearing. I will never forget what a general manager once said in my presence, and that was that he was always willing to give a salesman fifteen minutes of his time, that he felt he could learn something in those fifteen minutes, and if he could, he was willing to give him another fifteen minutes at some other time. He felt that such a man could bring him something—being a specialist—and all he wanted was to know enough of those specialists or know where he could get them.

A good many years ago, I remember very distinctly, a salesman came down from Chicago. They had a very large contract in mind and my superior was out at the time he called, so he went over his proposition with me, in detail. He spent probably an hour in this discussion and, as I was rather inquisitive at the time, as he left I said: You are a man about sixty years of age and I am a youngster of twenty-five. Why do you give me so much of your time? He replied: "You seem interested and some day you may be in a position where you will be buying those things. I may not be in a position to make that sale, but it is my line, and if I treat you well now, my concern might make a sale. I think I am doing missionary work which will pay us." I have always remembered that, and I have always felt that men who will go out in the world with that impression about their business and the value of it, will get along pretty well.

Mr. Wilcox says there is often a feeling that things are not being done as they should be, and that reminds me of an incident recently related by the proprietor of a large bridge building shop. He was telling of his experience with a railroad company in which a large bridge contract was at stake. Fortunately, he landed the contract, but before it was awarded the general manager told him he had added it up wrong, and asked him if he had not made a mistake of $3,000. When he figured it over he found that he could deduct $3,000, so he changed his figures, feeling he was getting a fair price at that. When he got home his president said, "Well, I see you secured the contract. What sort of a fellow is the general manager of the railroad?" He replied, "I brought the contract home and I call him a gentleman, but if I had not brought home that contract, I would have called him a mean chap."

Mr. F. J. Bullivant. There is one point which I would like to bring out, and that is in the case of machinery where the firm has standard apparatus and is also willing to build special apparatus, I think it is just as much the salesman's work, other things being equal, to persuade the customer that the standard apparatus is what he needs, as it is to take the order on anything special he might ask for; because many times the special apparatus the customer asks for will be no better for his service than some of the standard apparatus the manufacturer has and on which the manufacturer can give him better service, better delivery and generally a better price.

Mr. E. D. Smith. I think you might also add, Mr. Bullivant, that the manufacturer will make a greater return on his standard apparatus, hence the greater motive for so instructing the salesman.

Mr. F. J. Bullivant. Perhaps that is true, but at the same time the salesman can make a better proposition on the standard apparatus and so help out the customer.

Mr. W. H. Reeves. That is true, but sometimes it is necessary to sell special apparatus where standard apparatus would do just as well because some customers have ideas of their own and won't accept anything else.

One thing I did omit was a list of cautions, that is, things *not to do,* and if I had prepared such a list item No. 1 would have been, *Don't talk too much; you might talk yourself out of an order.*

Mr. A. P. Greensfelder. There is one point on which I did not understand Mr. Reeves clearly. He said he did not feel there was much profit in advertising in a technical journal. Is it not a fact that most engineers refer to the technical journals when they are in the market for machinery? Recently, I recall, we were in the market for a locomotive crane. We knew there were several standard makes of good cranes. We turned to the Engineering News and dropped a postal card to two or three concerns around the country who make good locomotive cranes. We received responses, either in personal solicitations from their salesmen or by correspondence, and in one case by long distance phone.

This reminds me of how the fellow arranged the sale. There were a couple of St. Louis representatives, but I must say they were slow, because in ten days we did not get a call. The Chicago man called us up by long distance phone. He said our matter was referred to him and that he had a salesman in Iowa, and wanted to know if he sent this man down from Iowa whether we would have a talk with him. We told him it was not necessary to send his man from Iowa; that if he mailed his proposition it would be fairly considered. However, he preferred to send the man. The man from Iowa knew his machine; knew what it could do, and knew exactly what we wanted, and in less than an hour he walked out with a signed contract. Now that is efficiency backed up by the firm behind him. They knew they had a good salesman and were willing that he should have a chance.

Mr. W. H. Reeves. I am willing, Mr. Greensfelder, to agree that advertising pays in selling machinery, but my remark was directed mostly to the selling of engineering services, and I followed same with the suggestion that probably there was no consulting engineer present whose clientele is, to any great extent, composed of regular subscribers to the engineering papers. I would like to know, in a general way, if that is true

Mr. E. D. Smith. I would be inclined to agree with Mr. Reeves that the clientele of the consulting engineer is composed, in the main, of business men who do not read the technical journals. If they were interested enough in engineering matters to read the technical journals, they might probably consider themselves sufficiently well versed in engineering matters to attempt to handle, at least in part, their own engineering work.

Mr. W. H. Reeves. I imagine any engineer can easily account for the various jobs he gets. He usually knows how they happen to come his way, and they probably do not come through advertising in any journal. My theory is that the engineering papers are read principally by engineers and those selling engineering materials and that parties needing the services of consulting engineers would hardly go to such a directory to locate an engineer.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

BUILDING LAWS.

By Henri Rusch,*
Member of the Engineers' Club of St. Louis.

[Read before the Club, September 23, 1914.]

Introduction.

In other cities the subject of this paper has been amply treated and discussed in its various forms. No doubt many of those present this evening have had experience with the building codes of other municipalities.

I must confess to having approached the preparation of this paper with considerable hesitation, due to the fact that the time allotted me for this work was very brief, and also on account of the difficulties involved in doing this subject full justice. As a member of Engineers' Club, I also felt it incumbent upon me to give an idea of the manner in which the building code is at present administered. In addition to this, I will attempt to furnish a brief outline of the revised building code, which the Building Commissioner of the City of St. Louis is about to submit to the different societies, committees and the public at large.

The Necessity of Building Laws.

The necessity of building laws has been sufficiently demonstrated in different ways, and many city departments are to-day depending for their efficiency on the enforcement of these laws. For example, let us take the board of health: Would it be possible for this department to maintain sanitary conditions in this city if the building code did not regulate plumbing and sanitation in buildings? Also, the fire department looks to these laws as a means to preventing the spread of fires from building to building, which often causes conflagrations that devastate whole city blocks. In regulating construction and securing provisions for safety by means of properly constructed walls, stairs, fire-escapes, exits, etc., the firemen are assured added protection. The ever-present danger in poorly constructed buildings where collapse may come without warning, thereby burying beneath tons of wreckage the helpless inmates is well known to all present.

A still further illustration of the value of building laws is furnished in congested tenement districts. Here, if the law is

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properly enforced, will result health and happiness to the tenants, by regulating light and air supply to each room, eliminating narrow courts, and thereby furnishing to the growing generation a little more sunshine.

Building Laws as a Protection to the Contractor.

The individual interest of the engineer, the building contractor, and the various industries connected with the erection of buildings are, of course, very materially effected by a clear, definite building ordinance, strictly enforced. Such laws, giving complete information on all subjects, would be of inestimable benefit to all concerned, enabling them to design, estimate and execute work without fear of being put to extra expense through a misunderstanding of the law. We all realize that a carelessly drawn ordinance, only partly, or possibly not at all enforced, is a great menace to the legitimate and honest business on account of unscrupulous practices of certain contractors who underbid others and then substitute cheaper materials and workmanship which might result in inferior construction to a point where it is liable to become positively dangerous.

It is here that a clean cut, definite and carefully constructed ordinance is of enormous importance. Such an ordinance should have just enough flexibility to permit of the use of new and improved construction and use of materials where tests have demonstrated their value; but in all other respects the requirements should be set forth in a clear and positive manner so that final results are the same, whether as to workmanship or materials specified under the law, assuring to all concerned a "square deal."

The Legal Side of Building Laws.

According to the common law and the fundamental principles concerning property rights, we have hardly changed from the old Roman law, in that a person has the right to use his own property only to the extent that he does not thereby injure that of his neighbor. This law is largely followed in building ordinances, and many sections are devoted to the protection of property from injury which might be caused by the action of a careless or malicious neighbor.

When civilization was in its first stages, people formed communities so as to be better enabled to defend themselves

against foes from without—from the rapacity of wild beasts and raids of their fellow-beings. But at present, community organization is indispensable as a defense against foes from within. Nor are these as few as might be imagined; for greed, carelessness and selfishness are the great obstacles in the development of a neighborly spirit.

Here the general interest of the community must step in and demand of the individual what he demands of the community, and that is, safety of person and property.

Other parts of the ordinance of vital importance in eliminating the many dangers that beset the path of man in city life have to do with preventing loss of life through fires, by regulating the number and location of exits, fire escapes, stairways and other safeguards in all places of public assembly—in theatres, department stores, factories and hotels. Even the humble little billboard standing by the road side, acting as a screen for whatever may be behind it, is not overlooked by the law.

The enforcement of the building ordinance is very much facilitated by the power which the city holds over all property within its boundaries; thus the building commissioner is armed with legal right and authority in entering any building for the purpose of ascertaining its condition in regard to public safety. This right he in turn delegates to his inspectors and deputies. The city exercises a form of police power in this respect, and the general public is little aware of the fact that in the crowded aisles of the busy department stores, in theatres and assembly halls, the watchful eye of the building inspector is ever alert to any possible cause of danger.

When it is ascertained that any building, through age, decay or the general wear of the elements, has become unsafe to the occupants and dangerous to the public, the building department without delay, notifies the owner of such property to remove or repair his building. Conspicuous danger signs are then posted on the premises as a warning to the public. If, within a given time, the owner fails to wreck or remove the danger, the building commissioner has legal authority to proceed with the wrecking at once, charging the expense incurred against the property.

Relation of the Engineer to the Building Ordinance.

Those sections dealing with the structural requirements of buildings must necessarily come within the scope of an engi-

neer, since in all such sections, fibre stresses, in connection with formulae covering the design of structures, trusses, plate-girders, beams, columns and footings are given, and the proper application of these sections requires technical training and experience. Thus, all buildings, the construction of which involves the use of trusses, trussed beams, reinforced concrete, steel skeleton designs, etc., are referred to the engineer for examination. This examination also includes structural alterations in existing buildings. Only after a careful inspection of actual conditions and thorough examination of plans, recalculating and checking all important structural parts, should a permit be issued to proceed with such work. The value of a system of this kind to the architect and contractor is evident, as thereby the Building Department virtually assumes responsibility for the safety of such building by verifying the correctness of their calculations and work.

Immediately upon the beginning of actual work upon a building, inspection becomes necessary. The bearing value of the soil must be investigated and proper precautions taken to guard against excessive or uneven settlement where quicksand or other unfavorable conditions of the soil may be found to exist. This often entails additional work not indicated on the plans; such as driving piles or sinking caissons to bed rock. Inspection continues until the completion of the building, and is made as frequently as may be necessary to insure the erection of the building in conformity with the approved plans on which the permit had been issued, so that there can be no evading the law or substitution of improper materials or inferior workmanship.

Present Office Regulations and Administration.

All permits for the erection of buildings in this city must be applied for by filling out printed blanks—stating location, use, height, manner of heating, proximity to other buildings, etc.

Based on the total cost of the work, the city collects a fee for inspection. Accompanying the application two sets of drawings must be submitted, giving all information necessary, including structural details. After examination and approval of these drawings the permit is issued and the official stamp of the Department, including the date, is affixed to each separate sheet.

One of these sets is retained by the Department, the other returned to the applicant to be kept at the building for the convenience of the inspector of the Building Department. If, during the construction of such building, it should become desirable to deviate from the original plans, either by adding to the work or changing the construction, such permission is easily obtained by submitting additional drawings, which, after approval and stamping with the current date, are attached to the original. If this were not done, in looking up the plans after the building was completed, it might be found that the building actually constructed is altogether different from the plans on which the permit was granted.

An additional fee is collected only in case it is found that additions or changes in construction have increased the total cost of the work.

Present Building Inspection.

A very important work in the Building Department is assigned the building inspector. He is intrusted with the enforcement of the law in accordance with the drawings in his possession as the building progresses. For this purpose he is furnished with a set of plans which remain in his possession until the completion of the building and are then returned to the owner. A like set, kept at the building as previously stated, enables him to keep in close touch with the work going on. It also is his duty to see not only that these approved plans are closely adhered to, but also that the construction, materials and workmanship are in accordance with up-to-date standards of perfection and in compliance with the many sections of the ordinance. His task is therefore by no means an easy one, if he is conscientious in his position. He must be thoroughly prepared for his work by being fully acquainted with all sections of the ordinance.

But his duty does not end here. The fact that his position brings him in daily contact with the public engaged in building work as a representative of the city, requires also that he be of high character, honest, of sufficient ability, and competent to give advice and instructions in cases where the contractor or builder is undecided as to the best method to pursue under certain conditions. Therefore, it becomes quite evident that the selection and training of an efficient force of inspectors is not a

small task and adds to the difficulties encountered by the Building Commissioner in the administration of his office.

The City of St. Louis is at present divided into seventeen districts, an inspector being assigned to each district. His duties are as I have previously stated, and include all work done in his district, except that which special inspectors have in charge. These special inspectors cover the entire city and their work consists of looking after a certain part of the building. This insures better results by relieving the regular inspector to that extent. The special branches I refer to include theaters, moving picture show buildings, garages, hotels and lodging houses, fire escapes and plaster work, to which one inspector is assigned in each line of work and is held responsible for it by the Building Commissioner.

In addition to this there are three inspectors not assigned to any fixed duty, but are employed as needed in emergency work such as department store inspection in its busy season, bill board inspection and condemnation work on buildings. This force of inspectors is placed under a chief inspector who is assisted by a senior inspector.

The engineering department is conducted by an engineer and two assistant engineers who examine and inspect all work not covered by the general force of inspectors.

Building Committees.

It has long been the intention of the present Building Commissioner to have the ordinance revised or reframed so as to take in more modern construction and to give it a more convenient shape by cutting down sections of unnecessary length. A new system of classifying and grouping the contents, of indexing and cross indexing has become a matter of absolute necessity, since many complaints in this respect were heard in regard to the existing ordinance.

With this in view he appointed a number of committees selected from the different professions, societies, trades, business interests, etc. This Club was also invited to appoint a committee to assist in the work and to meet with other committees to find ways and means to get it properly under way. After several meetings and some quite heated discussions, the members of several of these committees lost interest in the work. Therefore, the Building Commissioner instructed his employees to

get all the material available into such shape that it could be easily passed on.

There is now a wealth of suggestions available, but it is the wish of the Building Commissioner that the finishing touches to this ordinance shall be furnished by the committees appointed by him for this work. It would therefore be advisable, in my opinion, that the committee appointed by this Club take this matter in hand at an early date.

Revised Building Code.

We will now take a glance at the revised building code. The first thing we notice is that it is bulky. To read it to you in its entirety would, I fear, be an imposition on your patience. I will, therefore, with your permission, confine myself to reading only excerpts from sections that I believe to be of somewhat more interest to you than others. This ordinance embraces 242 sections, and as no indexing or grouping of these sections has as yet been attempted, I have taken the liberty of grouping them temporarily, so as to suggest some possible way in which this could be accomplished. The different sections might be distributed as follows:

	Sections
Legal requirements	18
Board of Appeals	3
Classifications of buildings	11
Height of buildings	1
Tenement buildings	9
Quality of materials	1
Materials, workmanship and general requirements	64

This distribution probably could be further divided into three or four groups, making them smaller, and therefore more convenient for general use.

The structural requirements include:

	Sections
Skeleton construction	13
Reinforced concrete	5
Stairways, elevators and dumb waiters	13
Fire escapes, shutters and standpipes	7
Chimneys, flues and installation of boilers	15
Restriction of floor area	3
Hotels and lodging houses	9
Theatres	19
Bill boards	2
Unsafe buildings	7
Inflammable materials	8
Automobile Garages	18
Picture shows	11
Gas fittings	3
Sewers	1

This includes all sections and I have no doubt that the grouping could be very much improved upon by a careful sifting of the ordinance.

In order to save time let us pass the first eighteen sections of the ordinance dealing with legal requirements and take up the classification of buildings. The ordinance divides all types of structures into four main classes, which are as follows:

Buildings of the First Class.

I will read in full the following two sections:

Sec. 337. First Class Buildings. A first class building shall be constructed wholly of non-inflammable materials, with walls, floors and roofs constructed of masonry or concrete, or of iron or steel framework, filled between and around with masonry, concrete, terra cotta or other durable, non-inflammable and fire-resisting materials. All columns, girders, beams, struts and all structural members shall be protected with fire-proof materials, so put on and held in place as to effectually protect such members from the effect of fire, corrosion or an abrasion. All exterior columns and all girders or other framing supporting more than one story of masonry, shall be protected by a thickness at any point of at least eight inches of fire-proof material. All structural members of buildings of this class which may be subjected to unusual responsibility shall be especially protected and fire-proofed in such a manner as to effectually protect such members and their loads from risk of accident by fire or otherwise. All columns other than those above mentioned shall be protected by fire-proofing not less than three inches in thickness at any point. Floor and roof beams and other framing shall be protected by fire-proofing not less than two inches in thickness. In buildings of the first-class, wood shall only be used for the wearing surface of floors, and the necessary sleepers for their attachment, for windows and door frames, sashes, doors and finish around them, hand rails and treads for stairs, and wainscoting except where especially prohibited by this article. There shall be no woodwork of any kind built into masonry walls. Rough frames and nailing blocks of wood may be permissible to be built into non-bearing partitions of fire-proof materials. There shall be no air spaces between the top of any floor construction and the floor boarding, or below any wooden stair tread, or behind any woodwork, but all such spaces shall be

solidly filled with concrete, or plaster, or other fire-proof materials.

Sec. 338. What Buildings Shall Be First Class. Every building hereafter erected to be used as a school building, hospital building, asylum or sanitarium having more than two stories above the basement; and every building hereafter erected to be used as a hotel or lodging house, tenement house, apartment house or office building and having more than five stories in heighth above the basement; and every building hereafter erected to be used as a theatre, seating one hundred or more persons, and having seats for spectators above the main floor thereof; and every building hereafter erected exceeding one story in height and to be used as a garage or building wherein automobiles, motor cars or other vehicles, using oil, steam or electricity as a motive power are repaired; and every building to be used for the purpose of conducting or carrying on the business of dry cleaning in which gasoline, naphtha, benzine, or other volatile oils are used as a solvent or cleanser, and when such building is within fifty feet of the line of another owner or within fifty feet of any other building upon the premises, and every building hereafter erected to be used for the boiling of pitch, tar, rosin, turpentine, varnish or other inflammable substances, and every building hereafter erected within the fire limits to be used for the storage of cotton or hemp in bales or in bulk, for the purpose of baling or to be used for manufacturing purposes, also hay stored in quantities exceeding five hundred bales, and every room wherein is placed a high pressure steam boiler, and every building to be used for a boiler house where the distance to roof, ceiling or other wood work is less than eight feet from any part of boiler, shall be a building of the first class. Every building coming within the provision of this section as herein before described which shall be converted or enlarged for the uses above mentioned and every building hereafter erected, altered or enlarged, to a height greater than ninety feet, shall be a building of the first class and shall comply in this construction with all the provisions of this article relating to buildings of the first class.

Very few changes have been necessary in these sections.

Buildings of the Second Class.

The construction of this class of buildings is known as "slow burning construction." The beams and columns consist of heavy

timbers of a minimum size of 8 inches. The outer walls are of brick or stone. The minimum thickness of floors are 2 5-8 inches. If steel beams or columns are used, they must be fire-proofed all around as required in buildings of the first class. One additional inch of wood must be added to the calculated dimensions of columns. This is meant to furnish additional resistance to the effect of fire, so as to preserve the full strength of the column. (This is a change from the former ordinance which requires only the calculated size for columns). This class includes every building two stories in height and having an undivided floor area exceeding 7,500 sq. ft., and every building exceeding 75 ft. in height when not required to be of the first class must be designed as a building of the second class and must not exceed 90 ft. in height.

Buildings of the Third Class.

Type "A."

The construction of this class of buildings is what is commonly termed "joist construction." The outer walls are of brick, stone or concrete of 13 inch thickness. The floors are carried on joists, resting on wood studs. Stairs are of wood, and the roof covered with slate, tile or composition roofing. This type of building is not considered very safe for hotels, tenement buildings or office buildings, and for this reason, when more than two stories in height, shall not have an undivided floor area exceedings 2,500 sq. ft. The heighth of all such buildings is limited to three stories.

Type "B."

In order to provide greater safety in buildings of this class, a new type of construction called "semi-fireproof" has been added. The exterior walls are as in Type "A,"—either of brick, stone or concrete, or they may be of skeleton construction. The floor is carried on steel joists, spaced like wood joists, but with metal placed at the top and bottom and covered with not less than ¾ in. of cement plaster. These joists rest on I beams supported by steel or cast iron columns, fireproofed with cement plaster on metal lath to a thickness of 1 inch. Stairways and elevators must be constructed as required in buildings of the first class if such buildings are over two stories in height. Buildings of this class must not exceed 75 ft. in height, and the

undivided floor area must not be more than 7,500 sq. ft. when such building is more than two stories in height and used as an office building, hotel, tenement house, apartment, boarding or lodging house. An undivided floor area not exceeding 10,000 sq. ft. is permitted when used for other purposes than those mentioned above.

Metal joist construction has given very satisfactory results under severe tests in the East, and it is therefore deemed advisable to permit its use in our city so as to reduce, if possible, the loss of life from fire which the public has suffered in buildings where wood joist construction was employed.

Buildings of the Fourth Class.

All buildings not included in the former classes are buildings of the fourth class and are divided into buildings of different types. All buildings outside a certain line known as the "fire limits," are permitted to be of what is known as "frame construction," with wood siding and shingle roofs. Buildings inside the fire limits may be constructed of wood, but must have roofs of composition, tar and gravel, slate, tile or metal, and must not be built nearer than 3 feet to the line of another owner or nearer than 6 feet to any other building, unless separated therefrom by a brick wall. The distance from any street must be at least 10 feet. The area of such a building must not exceed 300 sq. ft. and the height 12 feet. Such buildings are not permitted to be used for a habitation. This class also includes grain elevators provided they are erected near the river front or in isolated localities. Also lumber sheds to protect lumber and other materials carried in stock, but such shelter must not exceed 20 ft. in height and must be open for at least one-third its height on all sides. The roof must be covered with composition, slate, tile or metal. The area of these shelter houses must not exceed 10,000 square feet. A distance of 3 feet from the line of any owner or other building must be maintained.

Buildings constructed of metal studs covered with Portland cement plaster on metal lath or sheet metal and roofed with tile, slate, metal or composition roofing, not exceeding 12 feet in height and 500 sq. ft. in area, are also permitted within the fire limits providing a distance of 6 feet from any other building is maintained. This type of building may be built on the line of adjoining property.

(The new part of this section of the ordinance consists in permitting the erection of the last mentioned buildings for garages and similar purposes, which may be placed on the property line, thus allowing property owners to use their ground to better advantage than formerly.)

The foregoing constitutes the four classes of buildings and concludes the classification.

Quality of Materials.

In this section it is stated that new materials not mentioned in the ordinance may be used, but tests must be made so as to fully establish their value in comparison with materials or construction covered by the building code.

Load Carried by the Soil.

The requirements give the minimum size of footings where the ground pressure on good clay is taken at two tons per square foot. The full dead load must be carefully figured, including partitions, to which is added a live load for all floors for office buildings, hotels, apartments and similar buildings, at 10 lbs. per square foot. For mercantile buildings and factories 20 lbs. per square foot is used, and for warehouses and similar buildings, 50 per cent of the total live load for which the building is designed.

Piling.

The Commissioner has the right to compel the contractor to make borings in order to ascertain the value and carrying capacity of the underlying stratum.

The carrying value of each pile is ascertained by the following formula:

$$P = \frac{2\ W\ H}{S + 1/10} \text{ for steam hammer.}$$

$$P = \frac{2\ W\ H}{S + 1} \text{ for drop hammer.}$$

S = penetration in inches under the last blow or the average under the last five blows.

H = fall in feet.

W = weight of hammer in pounds.

P = safe load in pounds.

At least two rows of piles are to be placed under brick walls less than 70 feet high, and three rows under walls over 70 feet

in height. Under walls less than 50 feet in height the piles may be staggered.

Concrete Piles.

Where concrete piles are used a compressive stress of 400 lbs. per square foot at the top must not be exceeded. Concrete piles must be tested and one-half of their test load will be allowed as the carrying load.

Concrete, Brick or Stone Piers.

Isolated piers of plain concrete, brick or masonry shall not be higher than six times their smallest dimension, unless found to require less thickness by the following formula:

$$P = C \times (1.25 - \frac{H}{20\,D})$$

in which P = the reduced allowed unit stress.
C = the unit stress given in section 464.
H = the height of pier in feet.
D = the least dimension of the pier in feet.

But no pier must exceed in height twelve times the least dimension.

Allowable Stresses for Masonry.

	Lbs. per sq. in.
Coursed rubble masonry laid in Portland cement mortar	200
Ordinary rubble masonry laid in Portland cement mortar	100
Coursed rubble laid in lime mortar	120
Ordinary rubble laid in lime mortar	60
First-class granite masonry laid in Portland cement mortar	450
First-class lime or sandstone masonry laid in Portland cement mortar	350

Stresses for Concrete not Reinforced.

	Lbs. per sq. in.
Portland cement concrete, 1:2 :4 mix	350
Portland cement concrete, 1:2½ :5 mix	250
Portland cement concrete, 1:3 :6 mix	200
Natural cement concrete, 1:2 :5 mix	100

Stresses for Brick Work.

	Lbs. per sq. in.
Vitrified paving brick laid in 1 part Portland cement and 3 parts sand	350
Strictly hard pressed brick in same mortar	250
Ordinary hard red brick in same mortar	200
Ordinary hard red brick laid in Portland cement, 1 part lime and 3 parts sand mortar	175
Merchantable brick in good lime mortar	100

Stresses for Timber.

	Tension with grain	Compression with grain	Compression across grain	Shear with grain
Long leaf yellow pine	1,800	1,100	250	130
Oak	1,800	1,000	500	200
Short leaf yellow pine	1,000	800	250	120
White pine	800	700	200	80
Hemlock	600	500	150	60

The unit stress on timber posts is found by means of the formula:

$$C \times \left(1 - \frac{L}{80\, D}\right)$$

in which C = compression strength.

L = length in inches.

D = least diameter of post.

The maximum length of the post must not exceed thirty diameters.

Maximum Stresses for Steel and Iron.

	Rolled steel	Cast steel	Wrought iron	Cast iron
Tension on net section	16,000	16,000	12,000	
Maximum compression on gross section	14,000	14,000	10,000	10,000
Bending on extreme fibre	16,000	16,000	12,000	
Bending on extreme fibre tensions				3,000
Bending on extreme fibre compression				10,000
Shear on brackets				2,000

The allowable compression stresses per square inch are found by means of the following formula:

For steel, $16{,}000 - 70\frac{L}{R}$

For cast iron, $10{,}000 - 60\frac{L}{R}$

For wrought iron, $12{,}000 - 60\frac{L}{R}$

Wherein L = length in inches,

And R = least radius of gyration in inches.

For steel columns filled with and encased in concrete extending at least 3 in. beyond the outer edge of the steel, where the steel calculated to carry the entire live and dead load, the allowable stress per sq. in. may be determined by the formula:

$$18{,}000 - 70\frac{L}{R}$$

But shall not exceed 16,000 lbs.

Stress due to eccentric loading must be added in columns. The length of rolled steel compression members shall not exceed 160 times the least radius of gyration, but the limiting length of struts for wind bracing only may be 200 times the least radius of gyration.

The limiting length for cast iron columns shall be 70 times the least radius of gyration.

Plate Girders.

Plate girders shall be proportioned either by the moment of inertia of their net sections or by assuming that the flanges are concentrated at the centers of gravity and a unit stress used so that the extreme fibre stress does not exceed 16,000 lbs. per sq. in. in which case ⅛ of the gross section of the web, if properly spliced, may be used as flange section. The gross section of the compression flanges of plate girders shall not be less than the gross section of the tension flanges, nor shall the stress per sq. in. in the compression flange of any beam or girder, of a greater length than 25 times the width, exceed

in which formula $20{,}000 - 160\frac{L}{B}$

L = unsupported length, and

B = width of flange.

Loading of Floors.

The minimum live loads per square inch for which the floors of the different buildings must be designed are as follows:

	Lbs. per sq. ft.
Stores, factories, commercial buildings and warehouses	150
Office buildings, on all floors above the first floor	60
Office buildings, on first floor	100
Places of public assembly, schools and theaters	75
Dwellings, hospitals, hotels and tenement houses	50

Flat roofs must be designed for 30 lbs. per square foot.

SEC. 159. *Notice to be Posted on Each Floor.*—When the correct estimate of the weight that the floor in any manufacturing or commercial building will safely sustain has been ascertained and verified by the city, the Commissioner of Public Buildings shall approve the same, and thereupon the owner or occupant of said building, or any portion thereof, shall post a copy of such approved estimate in a conspicuous place on each story of the building in which it relates. Before any building shall, after ninety days from the passage of this ordinance, be used or occupied, in whole or in part, for any of the purposes aforesaid, the weight that each floor will safely sustain upon each superficial foot thereof shall be ascertained and posted as herein specified.

Live and Dead Loads Carried by Columns.

This section has not been changed except that the table giving the reduction of the live load for the different stories is added.

SEC. 161. *Loads on Walls, Piers and Columns—Dead and Live Loads.* (a) The full live load on roofs of any building shall be taken on walls, piers and columns. (b) The walls, piers and columns of all buildings shall be designed to carry the full dead loads and not less than the proportion of the live load given in the following table:

Floor	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
17	85 per cent.																
16	80	85															
15	75	80	85														
14	70	75	80	85													
13	65	70	75	80	85												
12	60	65	70	75	80	85											
11	55	60	65	70	75	80	85										
10	50	55	60	65	70	75	80	85									
9	50	50	55	60	65	70	75	80	85								
8	50	50	50	55	60	65	70	75	80	85							
7	50	50	50	50	55	60	65	70	75	80	85						
6	50	50	50	50	50	55	60	65	70	75	80	85					
5	50	50	50	50	50	50	55	60	65	70	75	80	85				
4	50	50	50	50	50	50	50	55	60	65	70	75	80	85			
3	50	50	50	50	50	50	50	50	55	60	65	70	75	80	85		
2	50	50	50	50	50	50	50	50	50	55	60	65	70	75	80	85	
1	50	50	50	50	50	50	50	50	50	50	55	60	65	70	75	80	85

and for each succeeding floor above, a proportion diminished by not more than five per cent, but in no case shall the live load of a floor be taken at less than fifty per cent of its calculated amount; and the required supporting capacities so determined shall be the minimum permissible for factors of safety and allowable stresses given in other parts of the ordinance.

Loads on Girders.

A reduction of the live load to 85 per cent of the panel load is permitted.

SEC. 470. *Wind Pressure on Skeleton Buildings.*—The frame work of a skeleton building shall be constructed to resist a horizontal wind pressure of thirty pounds per square foot on all exposed surfaces above grade. Where there are buildings immediately adjoining, the wall surface covered by such buildings will be considered as not exposed to wind pressure. The factors of safety to be used in computing the sections required to resist wind pressure shall be such that the unit stresses provided in Section 464 of this article, shall not be exceeded by more than twenty per cent.

SEC. 471. *Construction Shall Conform to Accepted Standards.*—The materials and workmanship of construction for the framework of skeleton buildings shall not be inferior in quality to the requirements of the standard specifications of the "Association of American Steel Manufacturers."

Reinforced Concrete Construction.

Theory of Stresses.—The method used in computing the stresses shall be such that the resultant unit stresses shall not

exceed the prescribed unit stresses as computed on the following assumptions:

(1) That a plane section normal to the neutral axis remains such during flexure, from which it follows that the deformation in any fibre is directly proportionate to the distance of that fibre from the neutral axis.

(2) That the modulus of elasticity remains constant within the limits of the working stresses fixed in these regulations and is as follows:

Steel, 30,000,000 lbs. per square inch.

Burnt clay concrete, 1,500,000 lbs. per square inch. All other concrete, 2,000,000 lbs. per square inch.

(3) That concrete does not take tension, except that in floor slabs and beams, secondary tension induced by internal shearing stresses may be assumed to exist.

Unit Stresses.

Unit Working Stresses.—The allowable unit stresses under a working load shall not exceed the following:

Burned clay concrete—

Direct compression, 300 lbs. per square inch.
Cross bending, 400 lbs. per square inch.
Direct shearing, 120 lbs. per square inch.
Shearing where secondary tension is allowed, 15 lbs. per square inch.

All other concrete—

Direct compression, 500 lbs. per square inch.
Cross bending, 800 lbs. per square inch.
Direct shearing, 135 lbs. per square inch.
Shearing where secondary tension is allowed, 25 lbs. per square inch.
Tension in medium steel, 16,000 lbs. per square inch.
Tension in high elastic limit steel, 20,000 per square inch.

Continuous Girders, Beams and Slabs.—In girders, beams and slabs continuous over two or more supports, the positive bending moment must not be less than $\frac{WL}{12}$ if uniformly loaded; but all such girders, beams and slabs, shall be reinforced over the supports to take the full negative bending moment. In no case, however, shall the negative bending moment for continuous beams be less than $\frac{WL}{}$.

Girders, Beams and Slabs Continuous on One Side Only.—Girders, beams and slabs, continuous on one side only and simply supported on the other, shall be calculated for a minimum positive bending moment of $\frac{WL}{10}$ for a uniformly distributed

load. The negative bending moment over the continuous support must not be less than $\frac{WL}{20}$.

Girders, Beams and Slabs Simply Supported.—Girders, beams and slabs simply supported must be proportioned to resist a positive bending moment not less than $\frac{WL}{8}$ for uniformly distributed loads. But in all beams and girders anchorage over the supports must be furnished where it is possible, by extending the bent up reinforcing rods into adjoining walls or slabs.

T Beams.—In designing T beams, the width of the floor slab, which may be assumed to act as compression flange of such beam, shall not exceed the width of the beam plus six times the thickness of the adjoining floor slabs, but in no case shall it exceed the distance center to center of beams, in all cases where it is possible, negative reinforcement must be used.

The letters used in the above formula are as follows:

W = total load on the span.

L = the center to center distance between supports.

Hooped Columns.—If a concrete column is hooped with steel near its outer surface either in the shape of circular hoops or of a helical cylinder, and if the minimum distance apart of the hoops or the pitch of the helix does not exceed one-tenth the diameter of the column, then the strength of such a column may be assumed to be the sum of the following three elements:

(1) The compressive resistance of the concrete when stressed not to exceed eight hundred pounds per square inch for the concrete enclosed by the hooping, the remainder being neglected.

(2) The compressive resistance of the longitudinal steel reinforcement when stress does not exceed 12,000 lbs. per square inch.

(3) The compressive resistance which would have been produced by imaginary longitudinals stressed the same as the actual longitudinals; the volume of the imaginary longitudinals being taken at two and four-tenths (2.4) times the volume of the hooping. In computing the volume of the hooping it shall be assumed that the section of the hooping throughout is the same as its least section. If the hooping is spliced, the splice shall develop the full strength of the least section of the hooping.

It is the intention to make some additions to this part of the ordinance, especially in regard to flat slab design, but it would consume a good deal of your time to go into this kind of construction now. I will state, however, that under the revised ordinance, the fibre stresses in concrete and steel are kept at the same height as before, with the exception of the direct

shearing stress in beams, which has been reduced from 175 lbs. to 135 lbs. per square inch.

Conclusion.

In conclusion I would say that I hope I have awakened in you a feeling of interest in our building laws. As engineers, you are among the main carriers of civilization, but civilization often imposes burdens, and I hope that this paper, if accomplishing nothing else, has succeeded in impressing you with one fact: That you cannot afford to be disinterested as far as city affairs are concerned. It is my firm conviction, that with suggestions from you, and the deeper interest taken by you in this work, that I see no reason why we should not soon have the best building ordinance in the country.

[NOTE—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

THE TECHNICAL SOCIETY OF THE PACIFIC COAST.

Owing to the peculiar and unusual conditions, the Technical Society of the Pacific Coast will cease to exist as an active engineering society at the end of this year. This Society was organized in 1884, and in the words of its Secretary, "it has passed through all the stages of development, from its birth to its full growth and virility, followed by its gradual decline."

"The decline has not been the fault of anyone in particular, but the conditions and environments, uncontrollable by any policy, have brought about the gradual lack of interest in this organization. Since the great catastrophe of 1906, the Society has never rallied from the great blow which it received then.

"Its belongings were destroyed by the fire, and its members were scattered in all directions, so that a complete unification has not been possible since.

"Soon after the sad event just referred to, the great National Societies of America organized local branches in San Francisco. The local members of the American Society of Civil Engineers, Mechanical Engineers, Electrical Engineers, etc., formed local organizations of their own, and since this has become the age of specialization, the old Technical Society lost its sphere of usefulness, as it were. It was created at a time when the term *Engineering* embraced all the technical professions, and its members were recruited from every technical calling. As soon as the National Societies had a large local representation, each individual group became affiliated with the society of its special calling, and in this way these men gradually drifted away from the Technical Society and became lost to it.

"Against all these odds the older members have been making a futile effort to hold up their old organization, but the spirit of it had flown; the meetings remained unattended; from year to year the membership grew less, and it finally came to the point where a decision had to be reached as to the future of the old organization.

"A meeting was held on Thursday evening, September 17, 1914, and the matter was fully discussed, with the result that a Committee was appointed, consisting of Vice-President Hermann Kower, Past President George W. Dickie and the Secretary, Otto von Geldern. This committee was given full power to act in the mattter, with the understanding that the Society

will have to go into a forced inactivity because of the fact that its finances do not permit a continuation of the expenditures required to meet existing conditions.

"This committee met on the evening of September 30, 1914, and came to the following definite conclusions:

"1. That the Technical Society become inactive with the end of the year 1914.

"2. That the dues from members be collected to the first of January, 1915, and that all membership dues cease for an indefinite period after that.

"3. That the affiliation of the Technical Society with the Association of Engineering Societies, and its obligations to pay its assessment for the Journal, cease with the end of the year 1914.

"4. That the modest sum of money in the hands of the Treasurer, after the payment of all debts, remain intact, and that for the present it be placed in a savings bank to draw interest, and that the custodian of this fund be the present Vice-President, Professor H. Kower; Past President, George W. Dickie; and present Treasurer. Adolf Lietz. and the Secretary, Otto von Geldern.

"5. That the inactivity of the Society be continued for such time until it shall be deemed proper by the present Board of Directors to resume its regular activities again, depending upon the proper occasion to make such reactivity desirable.

"6. That the present Board of Directors remain in office until their successors are elected.

"7. All members in good standing to July 1, 1914, remain members of the Society."

In closing his letter the Secretary adds: "We regret that this step had to be taken, but our financial condition makes it absolutely obligatory to cancel the agreement which we have so faithfully kept through the many years of our affiliation.

"The number of paying members is so small now and the constant reduction in membership so imminent that this radical step had to be taken sooner or later."

Yours very truly,

(Signed) OTTO VON GELDERN., *Secretary.*

OBITUARY

JOHN COIT ADAMS

MEMBER OF THE MONTANA SOCIETY OF ENGINEERS.

John C. Adams died in Butte, Mont., October 17, 1913, of an illness of more than a year's duration, resulting from an attack of pneumonia.

He was born in Honolulu, Hawaiian Islands, July 17, 1867, and came to Castine, Maine, at the age of eight years, where he entered school to complete his preparation for college. He entered Harvard College with the class of 1887. In 1888 he was employed at the Hope Quartz Mill at Philipsburg, Montana. The following year he went to the Bi-Metallic Mill in the same town. For several years he followed the profession of Mining Engineer, examining and reporting on mining property in various parts of the Western States. In 1898 he was married to Ethlyn Caldwell, and besides the widow, he leaves two daughters, Nina and Jaquelin.

In 1891 he entered the service of the Boston and Montana C. C. & S. Mining Co. as foreman of the Pennsylvania Mine. In 1904 he was appointed Superintendent of Mines for that Company, which position he held at the time of his death.

John C. Adams leaves an enviable record among the men with whom he was associated for exceptional ability and integrity. He was beloved and respected by all who knew him.

JOHN GILLIE,
B. H. DUNSHEE,
R. H. SALES,
Committee.

GEORGE R. BROWN

MEMBER OF THE MONTANA SOCIETY OF ENGINEERS.

George R. Brown was born at Cincinnati, Ohio, on April 19, 1865. When very young his parents removed to Walla Walla, Washington, where he attended high school and business college. When 19 years of age he removed to Silver Bow County, Montana, and was in the employ of Mr. W. A. McCune for about five

years, when he entered the employ of W. A. Clark of Butte and remained in his employ until his demise.

In 1893, he was appointed Superintendent of the Moulton Water Company, which supplied the inhabitants of Walkerville with water, remaining in that position until 1910, when he removed to Missoula to take charge of the water plant of that city, which was owned by Mr. Clark, the Moulton plant having been sold to the Butte Water Company. Later he was made general manager of the Clark interests in the city of Missoula, including the electric light and street railway in that community.

During his residence in Silver Bow County he served as Mayor of Walkerville and as County Commissioner of Silver Bow County for one term.

Mr. Brown was universally liked by all persons with whom he came in contact, either officially or personally. His universal courtesy to every one he met made him many warm personal friends in the communities in which he lived.

As a business man he was energetic and conscientious in the discharge of his duties, and while he was working for the best interest of his employers, he did so in a manner which made not only for himself, but for his employer, many friends.

He was extremely ambitious in the line of his profession, and was always ready to study and develop new ideas and modern methods.

In his death the community in which he lived loses an energetic, conscientious citizen and his employer an efficient and able lieutenant.

Be It Resolved, That in the passing away of George R. Brown, on September 4, 1914, the Montana Society of Engineers loses one of its most enthusiastic and valuable members, and that it extends to his bereaved family its heartfelt sympathy in this their hour of sorrow, and

Be It Further Resolved, That this report be spread upon the minutes of the Society and a copy sent to the family of the deceased.

J. H. Kyd,
Eugene Carroll,
W. J. McMahon,
Committee.

Association of Engineering Societies

Vol. 53. NOVEMBER, 1914. No. 5

PROCEEDINGS.

Montana Society of Engineers.

Butte, Montana, Sept. 14, 1914.

The September meeting of this Society was held at the appointed time and place, with President Sales presiding. Members present, Kyd, Sales, Munroe, Dunshee, Moore, Simons, Goodale. The minutes of the last meeting were approved. Mr. George E. Baker was elected to active membership in the Society. The following delegates to the Good Roads Congress, to be held at Atlanta, Georgia, Nov. 9-14, 1914, were appointed by the chair: Messrs. Shurick, Kneale, Davis, Mathewson and Sacket. The request of the Engineers' Club of Dayton, Ohio, for an exchange of Society Rooms and Library privileges was granted. The Secretary presented the resignation of Dr. Peter S. Mussigbrod, which was accepted. The Secretary also gave notice of the death of George R. Brown, an active member of the Society, and Messrs. Kyd, Carroll and McMahon were appointed to prepare a suitable sketch of his life for publication in the Society Journal. By motion, the Society voted to approve the action of the Board of Managers of the Association of Engineering Societies in amending the By-Laws of the Association. The Secretary was instructed to procure a paper on irrigation from Mr. John C. Beebe for the next meeting of the Society. Adjournment.

Clinton H. Moore, *Secretary.*

Butte, Montana, Oct. 12, 1914.

The October meeting of this Society was held in the Society Room, with President Sales presiding. Members present, Moore, Kyd, Sales, Munroe, Bacorn, Hobart, Bard, Cochrane. Minutes of previous meeting approved. The committee on resolutions on the death of George R. Brown, a valued member of the Society, presented the following, which was adopted: (See table of contents, Nov., 1914, issue of the Journal. Ed.)

Mr. Morse B. Davis and Mr. E. B. Howell favored the Society with a very interesting and instructive account of sabulite, the new mine

explosive, which has recently been "tried out" in the Butte mines and which seems to have demonstrated all the good qualities claimed for it.

Adjournment.

CLINTON H. MOORE, *Secretary.*

Oregon Society of Engineers.

Meeting of the Oregon Society of Engineers, Sept. 24, 1914., Room "A," Public Library Building.

Present, 45 members and visitors.

The meeting was called to order at 8:15 p. m., by President Graves, who presided.

The minutes of the meeting of June 25th were read and there being no corrections, were approved.

Mr. C. F. Blake, Chairman of the Library Committee, spoke at length upon the desirability of having some definite work for the Society to do. He called attention to the work of the Architects' Club in conducting a class in drafting for the younger men, and suggested that our Society could have different members speak to young engineers at various branch libraries and could outline a course of study which could be followed, by using books now found in the library.

Mr. J. C. Stevens advocated the use of the Metric System of weights and measures in the United States, and outlined a scheme for the organization of an Association for the Promotion of the Metric System, to be started by the Oregon Society of Engineers and to spread through the other technical societies of the United States.

After discussion by O. E. Stanley, R. E. Kremers, J. C. Stevens, C. S. Goldberg, H. L. Vorse, and W. H. Graves, Mr. Vorse moved that, "Mr. Stevens be appointed chairman of a committee of three to report at as early a date as possible, on means for carrying out the organization of 'The American Association for the Promotion of the Metric System'." The motion was seconded and carried. Mr. W. H. Adamson and Mr. A. J. Matter were appointed on this committee.

Mr. Stocker spoke of the desirability of having a club house, where Engineers could feel at home when in town for a short time.

Upon motion, he was appointed a committee to look into the question further, and report his findings.

Mr. Vorse moved that the Society indorse Mr. Dodson for a position as Commercial Attache in the Consular service. After discussion, this was carried unanimously.

Upon motion, the Library Committee was instructed to look further into the possibility of co-operation with the Library Board, and report as soon as possible.

Upon motion, the meeting adjourned.

ORRIN E. STANLEY, *Secretary.*

Meeting of the Oregon Society of Engineers, Oct. 8, 1914,
Room "A," Public Library Building.

Present, 15 members and 10 guests.

The meeting was called to order at 8:20 p. m., by President Graves, who presided.

President Graves introduced Mr. Charles E. Warner, who spoke on "Some Hitherto Unmentioned Features of the Los Angeles Aqueduct."

Mr. Warner had been Chairman of the Los Angeles Aqueduct Investigating Board, and had with him a copy of the report of that Board, together with photographs taken on the work.

He gave the impression that the aqueduct was started and carried out as a grand "steal" by some of the leading politicians of Los Angeles; that, so far as the water supply is concerned, it is not only useless to the city, but would prove a positive menace to life if it were to be used for domestic purposes; and that the only real use that the water can be put to, is to irrigate and boom some land owned by these same politicians who promoted the scheme.

There were many questions asked, and a very general discussion of the talk followed.

Mr. Graves spoke of the increasing demand by the members of our Society, who do not belong to one of the National Engineering Societies, for a badge, and called upon the Secretary to give prices that had been obtained for making badges.

Upon motion by Mr. Chamberlain, duly seconded and carried, the Secretary was instructed to have a die made, and some badges ordered, to be of the design which has been used on the Society announcements and stationery for some time past; the Society to bear the expense of the steel die.

The design is a forty-five degree triangle, bearing the words, "OREGON SOCIETY OF ENGINEERS."

Mr. Schuele, of the Portland Department of Public Works, invited the Society to accompany a group of Engineers on a monthly trip to some point of engineering interest, and was appointed a committee to arrange details.

Upon motion, the Secretary was instructed to send announcements of this trip to members of the Society.

Upon motion, the Society adjourned.

ORRIN E. STANLEY, *Secretary.*

Civil Engineers' Society of St. Paul

St. Paul, Minn., October 12, 1914.

The regular monthly meeting of the Civil Engineers' Society of St. Paul, was called to order by President Toltz, in the Palm Room of the St. Paul Hotel, at 7:50 p. m., Oct. 12, 1914.

There were 7 members present for transaction of business.

Moved, seconded, and carried, that the reading of the minutes of the last regular meeting of the Society be postponed to the next regular meeting.

Moved, seconded, and carried, that house and library privileges be exchanged with the Cleveland Engineering Society, Cleveland, Ohio; also with the Engineers' Club of Dayton, Dayton, Ohio.

Moved, seconded, and carried, that the appointment of Carl E. Nagel and John T. Stewart as a committee for the preparation of questions for the Civil Service Board of the City of Saint Paul, for use in examinations for filling positions in the Bureau of Engineering in the Department of Public Works, by President Toltz, be ratified.

Moved, seconded, and carried, that the Secretary cast the unanimous ballot of the Society for the election of the following applicants to membership in the Society, all approved by the Examining Board

For Full Membership: G. F. Barstow, 503 North Fourth street, Stillwater, Minn.; W. S. Jennings, care of Herzog Iron Works, St. Paul, Minn.; James F. Muir, 459 Selby avenue, St. Paul, Minn., and J. L. Mowry, 2342 Bourne avenue, St. Paul, Minn.

For Junior Membership: Geo. F. Krough, 1502 Hythe street, St. Paul, Minn.

Moved, seconded, and carried that the business meeting be adjourned (8:15 p. m.) to a time to be arranged for by President Toltz.

At 8:30 p. m., 24 members and 17 guests were called to order in the Palm Room of the St. Paul Hotel, to be entertained with an illustrated lecture on "The Everglades of Florida," by Mr. John T. Stewart, Agricultural and Forestry Engineer, of the University of Minnesota.

Edw. J. Dugan, *Secretary.*

Engineers' Club of St. Louis.

The 781st meeting of the Club was held on Saturday, October 3, 1914, as an excursion and trip of inspection around the west side belts of the Terminal Railroad Association, starting at the Union Station at 1:00 o'clock and stopping at several points of interest en route. The excursion was by courtesy of the Terminal Railroad Association. Members of the City Club, of St. Louis, were invited to attend. The total attendance was 240.

The following plants were visited: Flour mill of the Valier & Spies Milling Company; paint factory of the St. Louis Surfacer & Paint Co.; manganese steel foundry of the St. Louis Frog & Switch Co., and fireclay products plant of the Evens & Howard Brick Co. Representatives of the several plants guided members through, explaining processes and other points of interest.

Upon return to the Union Station at 6:30 o'clock, the meeting adjourned.

Joseph W. Peters, *Assistant Secretary.*

The 782nd meeting of the Club was held in the Club Rooms on Wednesday, October 7, 1914, at 8:15 p. m., as a joint meeting with the Associated Engineering Societies of St. Louis, under the auspices of the local section of the A. S. C. E. Members of the Academy of Science of St. Louis were invited to attend. Total attendance was 65.

President A. P. Greensfelder called the meeting to order and after the reading of the minutes of the Joint Council, called on Mr. E. E. Wall, Vice-President of the local section of the A. S. C. E., to preside. Mr. Wall then presented Mr. Gurdon G. Black, Engineer-in-Charge, St. Louis Water Works, who presented the paper of the evening, entitled: "The Chain of Rocks Filters."

Quite a number of very interesting lantern slides were shown, illustrating the paper. A short discussion followed.

Adjourned, 10:15 p. m.

Joseph W. Peters, *Assistant Secretary.*

The 783rd meeting of the Club was held in the Club Rooms, Wednesday, October 21, 1914, at 8:15 p. m. President A. P. Greensfelder presided. There were present 34 members and 11 guests.

Members of the St. Louis Section of the A. I. E. E. were invited to attend. This was not a "Party Meeting," as defined under the new Joint Regulations of the Associated Engineering Societies of St. Louis.

The minutes of the 780th, 781st and 782nd meetings of the Club were read and approved. The minutes of the 555th and 556th meetings of the Executive Committee were read.

The Assistant Secretary read a letter addressed to the President from W. S. Hawkins, of the Engineers' Club of Jefferson City, Mo., inviting him to be present at their meeting of November 7, and expressing desire of members of that organization to become affiliated with our Club. The reply to this letter by President Greensfelder was also read. The presiding officer mentioned that a committee had been appointed by the Joint Council to consider the matter of affiliating with the Jefferson City Club.

The Assistant Secretary read the following recommendation of the Legislative Committee:

> To the Members of the Engineers' Club of St. Louis:
>
> "The Legislative Committee has carefully considered the recommendations of the last Nominating Committee, together with the notes of discussion had about the matter by the Club members, and has decided to recommend the following amendment to Section 12 of the By-Laws:
>
> "On the fourth line of Section 12 of the By-Laws, as printed in the Annual of 1914, we have the phrase. 'The Nominating Committee shall select one Candidate for each office * * * .'
>
> "This Committee recommends that this phrase be amended so as to read: *The Nominating Committee shall select two or more Candidates for each office * * * .*

"On the last two lines of the same section, we have the phrase: 'The name proposed by the Nominating Committee shall stand first.'

"And this Committee recommends that this phrase be amended to read: *The names shall be arranged alphabetically.*"

Respectfully submitted,

J. T. Dodds,
L. R. Bowen,
O. F. Harting.

Mr. S. N. Clarkson announced that the St. Louis Section of the A. I. E. E. would hold a meeting in the large Assembly Room of the Public Library, Monday, October 26, 1914, at 8:45 p. m., when motion pictures would be shown illustrating the manufacture of steel tubing, inviting members of the Engineers' Club to attend.

Motion made, seconded, and unanimously carried, that the Assistant Secretary write a letter of thanks to Mr. H. J. Pfeifer, of the Terminal Railroad Association of St. Louis, expressing appreciation of the courtesy extended to this Club in connection with the excursion and trip of inspection of October 3, 1914.

The presiding officer then presented Professor A. S. Langsdorff, Dean of the School of Engineering of the Washington University, and Past President of the Engineers' Club, who delivered the paper of the evening, entitled, "Graphical Methods of Determining Characteristics of Direct Generators and Motors." The paper was illustrated by a number of graphical charts. A brief discussion followed.

Adjourned, 10:15 p. m.

Joseph W. Peters, *Assistant Secretary.*

The 784th meeting of the Club was held in the Club Rooms on Wednesday, October 28, 1914, 8:15 p. m., as a joint meeting with the Associated Engineering Societies of St. Louis, under the auspices of the St. Louis Branch of the American Society of Mechanical Engineers. There were present 44 members and 10 guests.

President A. P. Greensfelder called the meeting to order.

The minutes of the first Joint Meeting under the Joint Regulations were read and approved.

The minutes of the second meeting of the Joint Council were read.

In accordance with the recommendations of the Joint Council, printed in the notice for this meeting, the presiding officer called for vote. A unanimous vote was cast in favor of considering both propositions at this meeting in lieu of a referendum ballot returnable in ten days. Therefore, the question was put and vote separately taken on each proposition. The ballot resulted unanimously in favor of the recommendations of the Joint Council, that the Associated Engineering Societies of St. Louis go on record as favoring the proposed Central Parkway of the City of St. Louis, and the $2,750,000 bond issue to complete the Municipal Bridge.

President Greensfelder called upon Mr. F. E. Bausch, Chairman of the St. Louis Branch of the A. S. M. E., to preside. Chairman Bausch then presented Mr. John Hunter, Chief Engineer of Power Plants of the Union Electric Light & Power Co., who read the paper of the evening, entitled "Recent Developments of Steam-Electric Generating Stations." The paper was profusely illustrated by stereopticon views. Discussion followed.

Adjourned, 11:15 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

The 785th meeting of the Club was held on Saturday, October 31, 1914, as a trip of inspection through the plant of the Illinois Glass Company, at Alton, Illinois. The total attendance was 91.

The party started from the McKinley Station at 1:00 o'clock, arriving at the plant about 2:20 o'clock. Mr. T. C. Moorshead, Assistant General Manager of the company, a member of the Engineers' Club, supplied each person with a printed description of the plant and groups of eight or nine with a separate guide, who explained processes and points of interest.

Luncheon was served and each person given a souvenir of the product of the works.

The party returned to St. Louis about 6:30 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

The 786th meeting of the Club was held in the Club Rooms, Wednesday, November 4, 1914, at 8:15 p. m., as a Joint Meeting with the Associated Engineering Societies of St. Louis, under the auspices of the St. Louis Section of the American Society of Engineering Contractors. There were present 45 members and 4 guests.

President A. P. Greensfelder called the meeting to order.

Minutes of the second Joint Meeting under the Joint Regulations were read and approved.

President Greensfelder called upon Mr. James Adkins, Jr., Chairman of the St. Louis Section of the A. S. E. C., to preside. Chairman Adkins then presented Mr. Ernest S. Wiederholdt, of the Wiederholdt Construction Co., who presented an illustrated paper, entitled: "Various Kinds of Chimneys." The paper brought out an interesting discussion, participated in by quite a number of those present.

Adjourned, 10:15 p. m.

JOSEPH W. PETERS, *Assistant Secretary.*

ASSOCIATION OF ENGINEERING SOCIETIES

ORGANIZED 1881.

Vol. 53. DECEMBER, 1914. No. 6

EDITORIAL

We have been advised that the engineering societies of Utah and Louisiana desire to withdraw from the Association on December 31, 1914. The reason for Utah's action we have been unable to learn. In reference to Louisiana, the Secretary writes that their action is caused by no dissatisfaction with the Journal or with any of the features of the Association, all of which have been eminently satisfactory, but that after some discussion among the members of the Society and members of the Board, it was decided that the technical activities of the Society might best be fostered by the publication of its own Journal.

Now, we believe that any society with only 205 subscribers is making a grave mistake in attempting to publish a Journal simply for its own membership. In publishing a Journal, as in most other things, the arguments in favor of union and co-operation are still sound. A small society may succeed in publishing a few papers at long intervals, but it will cost the members as much, or more, for such unsatisfactory service as they now pay for a monthly Journal with three technical papers and much miscellaneous matter in each issue. Even the Boston Society, with 900 members, found it necessary to raise its subscription price to $4.00 for ten issues, while the Engineers' Society of Western Pennsylvania charges $5.00 for ten issues. The Engineers' Club of Philadelphia charges $2.00 for six issues and the Cleveland Engineering Society, $2.00 for six issues. All of these societies

are much larger than the Louisiana Society, which, therefore, cannot naturally expect better rates.

Now, it has occurred to the Chairman of the Association that there is a simple method by which this desire of the Louisiana Society, or of any other society, may be gratified and still have the members of that society furnished with all the papers of all the other societies in the Association, published promptly each month, as at present, and at the same time maintain the integrity and usefulness of the Association.

This can be done by eliminating all references to the Association on the first page of each issue and at the top of the even pages, and binding the text and advertising matter in a *separate cover for each society.* At the top of the cover would appear the name of the individual society in large letters (instead of "Journal of the Association of Engineering Societies"). The table of contents, giving titles of papers and authors, without names of societies, could be printed in the middle of the cover as formerly instead of the list of the constituent societies. Under this would appear in small type, Published monthly for the Society by Joseph W. Peters, 3817 Olive street, St. Louis, Mo. The place of publication would have to be shown in order to comply with the postal regulations.

Such a journal would contain all that any individual society journal would, and also the papers of the other societies, and at no greater cost. The author of a paper would then retain an audience of national scope, which is certainly a greater incentive to prepare good papers than the limited membership of the average local society. At the same time each club will secure the publication of its papers and proceedings with but little effort on its part and at reasonable cost for the amount of printed matter received. This is a great advantage to an organization in which the members have very little time to prepare for club work and which has but a limited revenue.

This is submitted for the serious consideration of the members of the Louisiana Society and of all the other societies. The Association is a mutual affair and its primary purpose is to furnish an organ of publication for the constituent societies. If this service can be rendered more satisfactorily and acceptably some other way than at present, the Chairman sees no reason why the plan here indicated, or some other plan, should not

be adopted. Furthermore, if any society wishes to publish announcements of future meetings, or any other matter not now published in the Journal, it should make its wants known. If it conflicts with the Rules of the Board, the Rules can be amended.

Prompt discussion and suggestions are invited and desired which will be published in the January issue.

John W. Woermann, *Chairman.*

SOME PRACTICAL APPLICATIONS OF THE PRINCIPLES OF STATISTICS.

By Charles S. Ruffner,*
Member of The Engineers' Club of St. Louis.

(Read before the Club, November 11, 1914.)

Introduction.

With the advance in scientific investigation and assembly of experimental data applicable to engineering problems, it would seem to the casual observer that engineering should partake more of the nature of a science than that of an art. While this is in part true, at the same time the most successful engineer is the one who, after making all the calculations which theory and experimental data permit, finally applies his judgment and arrives at a conservative answer. In point of fact good judgment is essential to the solution of all engineering problems and the various calculations in which we indulge are only means of guiding or testing such judgment.

The successful business man proceeds both by calculation and judgment. His experience ripens his judgment and permits him to take into account the various contingencies by which the future may modify his calculations. The technical engineer with his high degree of mental training in the use of formulae and principles of physical science, approaches a business problem from an entirely different angle than does the business man, in that the former gives far greater weight to the results of his calculations and depends less on his judgment, while the latter relies only in small part on his calculations and arrives at conclusions by sizing up and applying his judgment to the problem as a whole. The mental processes of the two are essentially different. To form a merger of these two processes in proper proportion is not without its temperamental difficulties, but when such merger is effected, the results usually speak for themselves.

The successful business man anticipates that his estimates will vary from experience and he undertakes to make proper allowance for such variation. The engineer concludes that after the application of the proper factors of safety in his formula, his conclusions should be safe and within the probable results.

Many of the calculations with which an engineer has to do involve elements of chance or other causes over which he and

*General Manager of the Mississippi River Power Distributing Co., and the Electric Co. of Missouri.

his clients will not be able to exert control. Even the most casual inspection of the practical results of any engineering calculation indicates that there are opportunities for wide variations in the answer. The engineer does not ordinarily undertake to measure these opportunities for variation in giving advice to his client, but often works with aevrages in the expectation that the value so derived is the most probable and accordingly the nearest fit to the clients' wishes. If he were to point out the entire range through which the values may operate and then leave to the client the determination of the most likely figure, many engineering recommendations would be greatly modified and engineering practice substantially changed, but it is doubtful if many clients would care for engineering advice proceeding along such lines, unless they were educated to exercise their own judgment in connection with technical data submitted by their engineer.

All engineering calculations at some point hinge upon experience, experimental or observational data. The calculations made by the engineer are designed for the purpose of applying such experimental data to the solution of the particular problem in hand. It develops that all experimental and observational data show wide variations, and it is to the reduction of such varying data that I wish to direct your attention in this discussion. Engineers instinctively recognize these possible variations, but as a rule, the influence thereof on their conclusions is neither definite nor always apparent.

Early Illustration of Variations.

Probably the first illustration that many of us recall, showing the frequency with which certain events may occur, is that of the drawing of black and white balls from a bag. As we advanced in our mathematical training we encountered the grouping of rifle shots around the bulls-eye. This led to the derivation of the symmetrical curve known as the "curve of errors" or "probability curve." We may have found a few examples of statistical groupings in which the theoretical law was presumed to have been followed. While engineers in geodetic calculations have utilized the method of least squares for the purpose of measuring the accuracy or variation of their observations, this principle has not come into general use for the purpose of modifying engineering judgment. It has been left to the economist and biologist to develop the detailed mathematics of variations and

means of measuring the same in a practical way. Economists in tracing the relations between the volume of trade, money, population, birth rate, death rate, corn crops, imports, exports, etc., in efforts to ascertain if there was any underlying relationship, have had occasion to tabulate these various factors in such a way as would disclose any such relationship if it existed. Likewise, biologists in endeavoring to trace hereditary factors have had occasion to tabulate their observational data in the same way. These tables so prepared showed variations as between frequency and magnitude, approximating that disclosed by the "law of errors" or "probability curve," and there followed the derivation of numerous formulae designed for the quantitative measurement of these variations, and the correlation, if any, that existed between the data.

Distribution of Observations and Properties of Normal Curve.

There are certain classes of observational statistics which group themselves around a line with a high degree of symmetry. Among these are data showing the relation between the stature and frequency of occurrence of Adult Males. Such a frequency table is the following:

Stature in Inches	Number of Adult Males	Stature in Inches	Number of Adult Males
57	2	67	1329
58	4	68	1230
59	14	69	1063
60	41	70	646
61	83	71	392
62	169	72	202
63	394	73	79
64	669	74	32
65	990	75	16
66	1223	76	5
....	....	77	2

When these data are arranged in graphic form, with stature as abscissae and frequency as ordinates, the diagram Fig. 1 results.

The data given in the table are represented by small circles; the frequency polygon would have been obtained by connecting the several points, but this has not been done in order to avoid the confusion resulting from the super-posing of the normal curve.

The smooth, symmetrical curve shown in Fig. 1 is the graph of the equation,

$$y = 1333\, e^{\frac{-x^2}{13.2}} \qquad (1)$$

where e equals the base of the natural system of logarithms. The

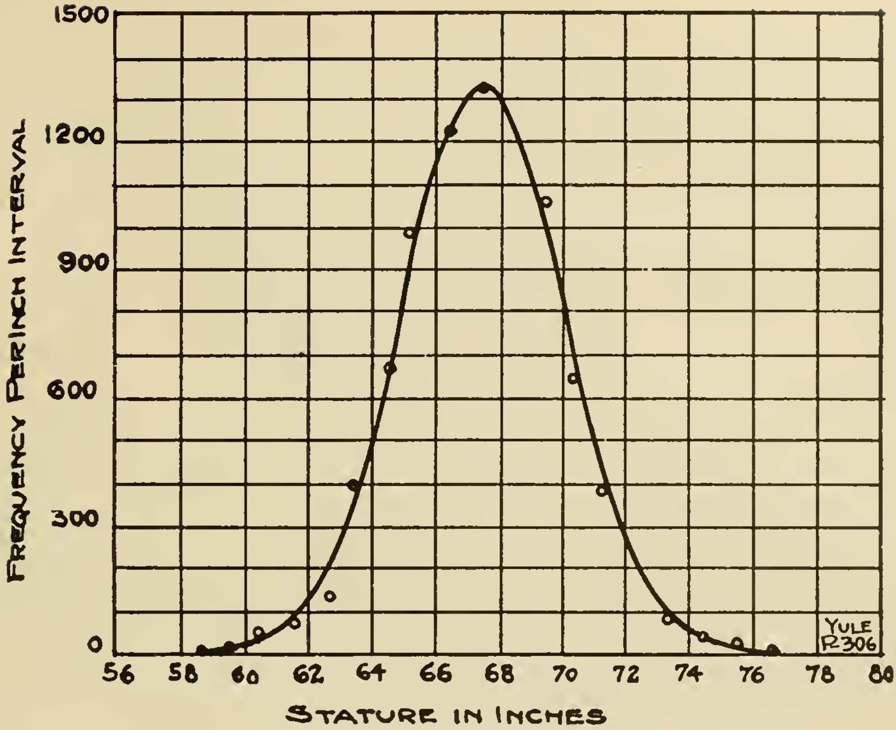

Fig. 1. The Distribution of Stature for Adult Males. Fitted with a Normal Curve.

curve fits the observed data with a high degree of closeness. It is symmetrical about a vertical axis passing through the maximum ordinate. The area within the frequency polygon and the normal curve is equal to the total number of observations.

The general equation for the normal curve is

$$y = \frac{n}{\sigma\sqrt{2\pi}} \cdot e^{-\frac{x^2}{2\sigma^2}} \qquad (2)$$

where y and x are the ordinate and abscissa respectively of the point.

n = total number of observations or variates

$\pi = 3.1416$

e = base of natural system of logarithms

σ = a constant for any one curve defining its shape, and called the "standard deviation."

Equation (2) is identical with the equation showing the relation between frequency and magnitude or errors (1).

No attempt will be made in this discussion to show the derivation of equation (2), and those interested are referred to the text books.

Tables showing the ordinates of the normal curve for various

values of the ratio $\frac{x}{\sigma}$ and the fraction of the area of the curve between the limits 0 and $\frac{x}{\sigma}$ are standard and available in the usual text books. Reference to such tables shows that within the range of x, equal to 4σ or 2σ on either side of 0, the proportion of the total area included is 0.9555

If y = probability of any error of magnitude x,

k and h = constants

$$y = e^{\frac{k}{-h^2x^2}}$$

(Merriman's Method of Least Square—p. 25—Eighth Edition.)

and within the range of 6σ, 0.99730. The fact that 99.73 per cent of all variates, having a normal distribution fall within the range 6σ is the basis for the rule that the great bulk of all observations will fall within the range of six times the standard of deviation. Experience shows that for other than normal distribution the rule holds good more often than it fails.

Statistical Factors.

Statisticians have developed for us certain factors which they have found convenient in defining the various quantities derived from observational data. When data are arranged in order of magnitude of the "independent variable" and there is associated with it the frequency of each magnitude, the table thereby resulting is known as a frequency table and if platted in graphic form, as a frequency curve. If in lieu of the individual units of each separate magnitude they be grouped to include ranges of magnitude, the curve resulting from the platting of such data is shown as a "polygon of loaded ordinates."

The *mean* value is equal to the sum of all the separate values divided by the total number of units or variables.

The *median* value is that with respect to which fifty per cent of the units are on either side.

The *mode* value is the one of greatest frequency.

The standard deviation is derived in substantially the same manner as the probable error in the method of "least squares," and it is the square root of the arithmetic mean of the squares of all deviations from the mean. It is represented by the formula:

$$\sigma = \sqrt{\frac{n_1(x_1 - x)^2 + n_2(x_2 - x)^2 + - n_n(x_n - x)^2}{n_1 + n_2 + \ldots\ldots\ldots\ldots n_n}}$$

The standard deviation is the most useful of all the statistical

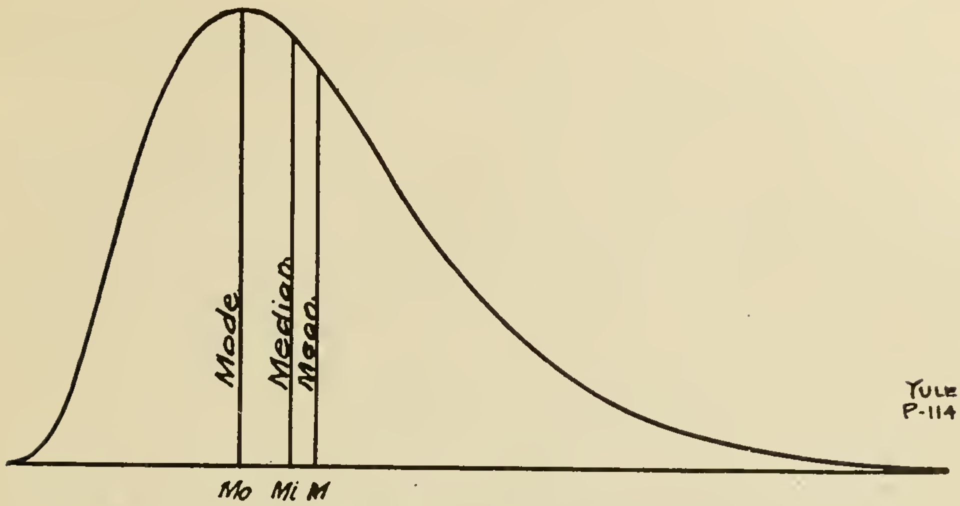

Fig. 2. Mean M, Median Mi, and Mode Mo, of the Ideal Moderately Asymmetrical Distribution.

factors for the purpose of indicating and measuring the dispersion between the various data. If the data cover a wide range and the frequency curve is not very pointed, the standard deviation will be large, while on the other hand, if the observational data are confined to a relatively small range, the standard deviation will be correspondingly small.

For example: The mean value of the data given in Table 1 and shown in Figure 1 is 67.46 inches; the median is 67.0; the mode 67.0 inches; and the standard deviation 2.57 inches.

Skewness or distortion from normal is measured by the formula:

$$\text{Skewness} = \frac{\text{Mean—Mode}}{\text{Standard Deviation}}$$

which may be approximately represented by the formula:

$$\text{Skewness} = \frac{3(\text{Mean—Median})}{\text{Standard Deviation}}$$

since the mode is approximately determined from the formula

$$\text{Mode} = \text{Mean} - 3(\text{Mean—Median})$$

Biological Applications.

Extensive use of statistical methods has been made in biological investigations. In order to permit conclusions to be drawn, the observations must cover a relatively large number of units. Mathematicians interested in biological work and particularly Pearson, have developed many equations for further tying together the various data, and tracing secondary, tertiary, etc., effects. This branch of the subject is not of great interest to engineers, but permits the derivation of conclusions that are without doubt of great interest to biologists.

The same general principles of classification and association of statistical data are used by the economists, either in testing their theories or in developing new ones.

In the hands of these scientists the subject has had a marked development in the last twenty years, and while the actual results or firm conclusions reached may not have been in full proportion to the work involved, the uses of large groups of figures have been developed and the limitations in accuracy of conclusions imposed by meagerness of data have been pointed out.

Applications to Engineering.

Of greatest interest to engineers are those applications of statistical methods that deal with technical data. The field has not been well explored and we can only make brief reference in this discussion to some of the problems which have been handled by others and appearing in the technical press and subjects which our own experience has developed.

(*a*) *Arrangement of Data.*

In any attempt to develop relations that may exist as between magnitude and frequency, it is usual to arrange the data in order of magnitude of units and indicate opposite each magnitude or range, the respective frequency. Such tabular statement is called a frequency table and is of the general form as that appearing

If the primary units are related to another group, each with their respective frequencies, that is, there are three variables to be considered, the table is similarly arranged but shows in addition the frequency of occurrence of each magnitude of primary units corresponding to each magnitude or range of secondary units. Such a tabular statement is known as a correlation table. An example of data arranged in this form is the following:

Table showing relation of hours worked per day and spread of duty.

HOURS WORKED AND SPREAD OF DUTY OF FREIGHT HANDLERS

Per 1,000 Men.

Hours / Spread of Duty	7.–7.5	7.5–8.	8.–8.5	8.5–9.	9.–9.5	9.5–10.	10.–10.5	Total
8. — 9.	8	3	1	1	....	....	....	13
9. — 9.5	6	34	7	3	....	....	....	50
9.5—10.	5	22	104	20	4	2	....	157
10. —10.5	4	17	84	107	84	18	7	321
10.5—11.	2	14	29	96	93	28	3	265
11. —11.5	....	5	14	32	30	44	24	139
11.5—12.	....	....	....	23	15	9	8	55
Total,	25	95	239	282	216	101	42	1000

(*b*) *Arrangement in Cumulative Form.*

If the ordinary frequency table be plotted in cumulative form, there results a curve differing in form from that of the usual frequency curve.

A comparison of the frequency curve and derived cumulative curve as applied to distribution of gas customers of a typical company is shown in Fig. 3.

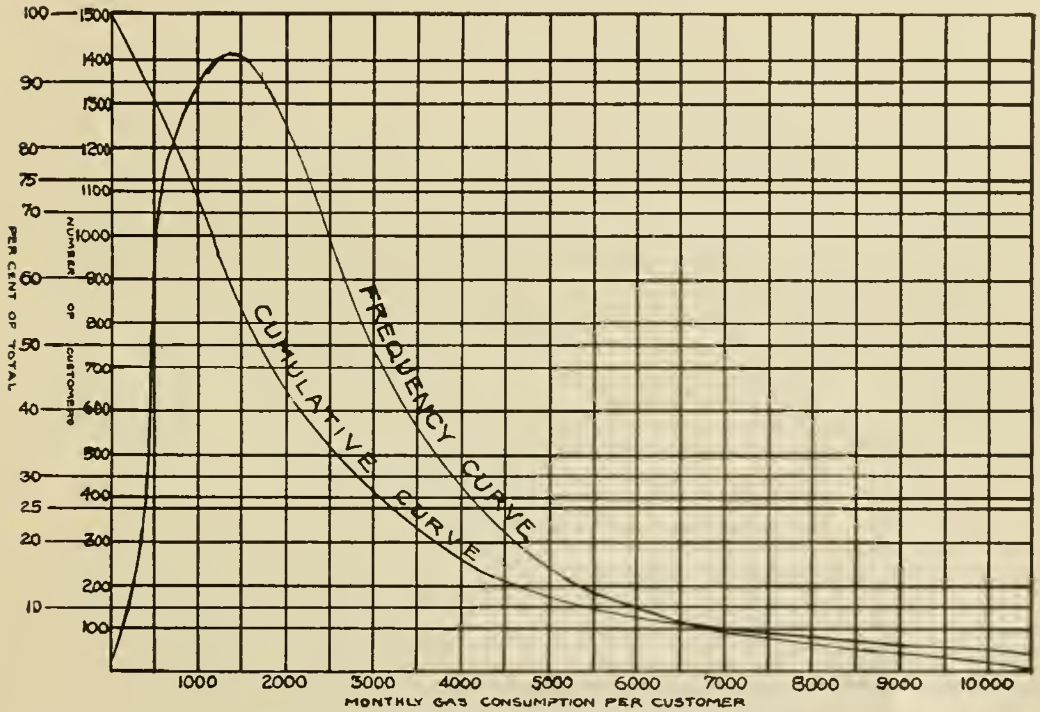

Fig. 3. Distribution of Gas Customers.

The number of incandescent lamps per residence gives the frequency curve shown in Fig. 4.

Similar curves may be drawn for the power output of electric power plants, and for a variety of other statistical data readily obtainable from the records of a public utility. The cumulative curve is almost invariably of much smoother contour than the frequency curve from which it is derived.

Applications of Cumulative Data.

Among the unusual practical applications of mass data arranged in cumulative form may be cited the following:

Development of Telephone Standard.

Some years ago the American Telephone and Telegraph Company carried on an extended series of observations with respect

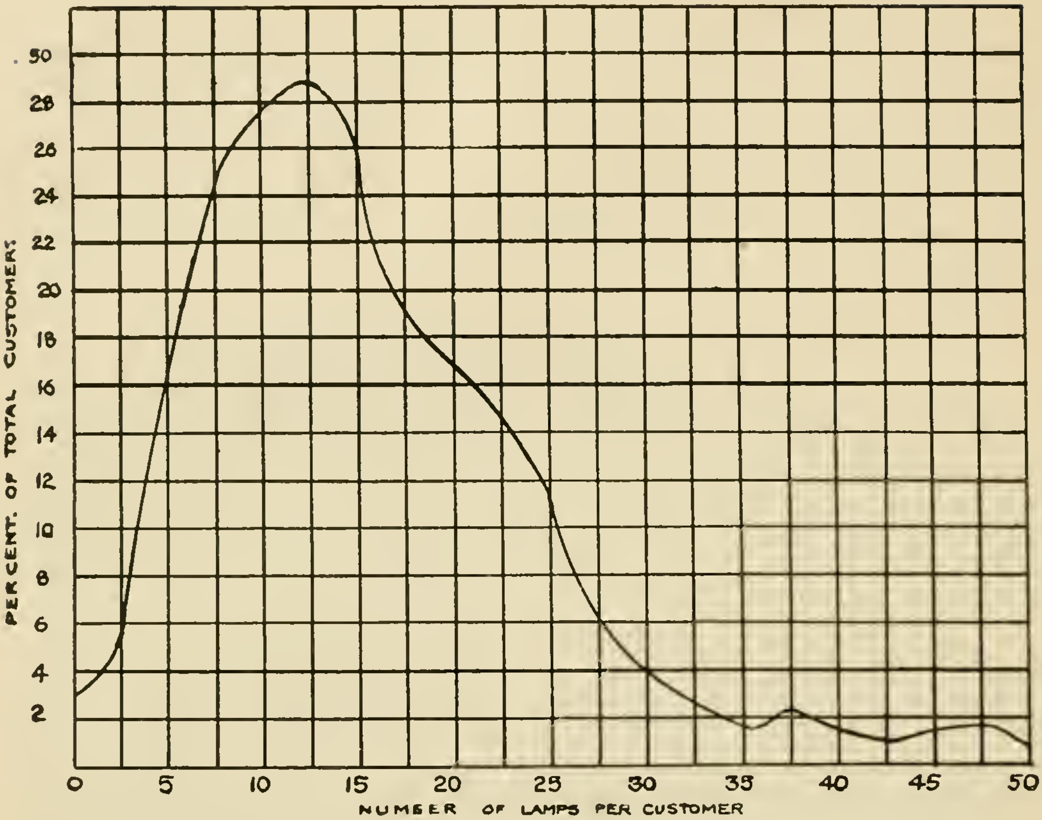

Fig. 4. Distribution of Incandescent Lamps in Residences.

to the time required to obtain an answer from operators of telephone central exchanges. The time required for an answer was shown to vary over a wide range. When, however, the data was arranged in cumulative form, it was practicable to develop standards to which a series of observations on a given exchange could be referred.

The Railroad Commission of Wisconsin subsequently applied the same general method to the same problem and the curve shown in Fig. 5 is reproduced from the report for 1910.

These and other data led to the development of the following rule for defining a reasonable standard for telephone service:

> RULE 7.—At exchanges serving five hundred or more subscribers, 94 per cent of the calls should be answered within ten seconds or less. At all other regular exchanges 90 per cent of the calls should be answered within ten seconds or less. At small exchanges, operated in connection with other work, slower service may be adequate.

Cement Specification.

Something of the same general idea underlies the specification

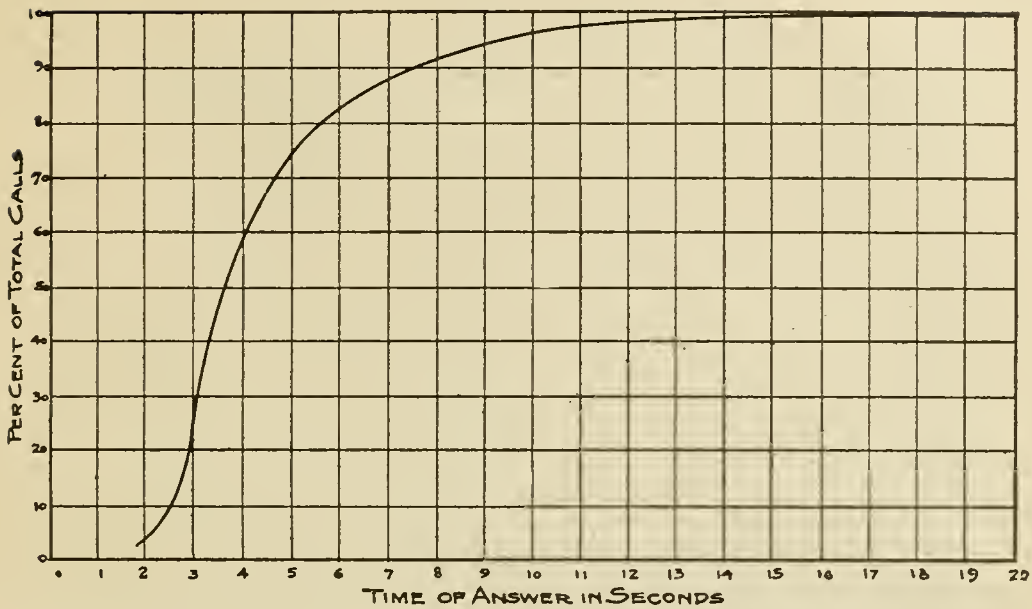

Fig. 5. Telephone Service in Wisconsin. Promptness of Operators in Answering Calls. Average Speed in Cities of over 10,000 Population.

of "Fineness" for Portland Cement adopted by the American Society for Testing Materials, viz.:

> It shall have by weight a residue of not more than 8 per cent on the No. 100 and not more than 25 per cent on the No. 200 sieve.

Loading of Street Cars.

An attempt has been made to apply the same principles to the definition of a standard of street car loading. The data underlying the resultant curve can not be given for the lack of time and space. However, it may be stated that an extended series of observations as to the number of passengers on street cars during rush hours, showed that the relation between number of passengers and seating capacity should be quite accurately shown by the curve given in Fig. 6.

Since it was recognized that the subject possessed indeterminate characteristics, so far as one car was concerned, it was necessary to refer the definition of any standard to the group or mass data and the following rule was proposed:

> The utility shall operate a sufficient number of cars at such capacity as it has available and in such order as it may determine during the rush hour period 5:30 p. m. to 6:30 p. m., so that the number of cars carrying the

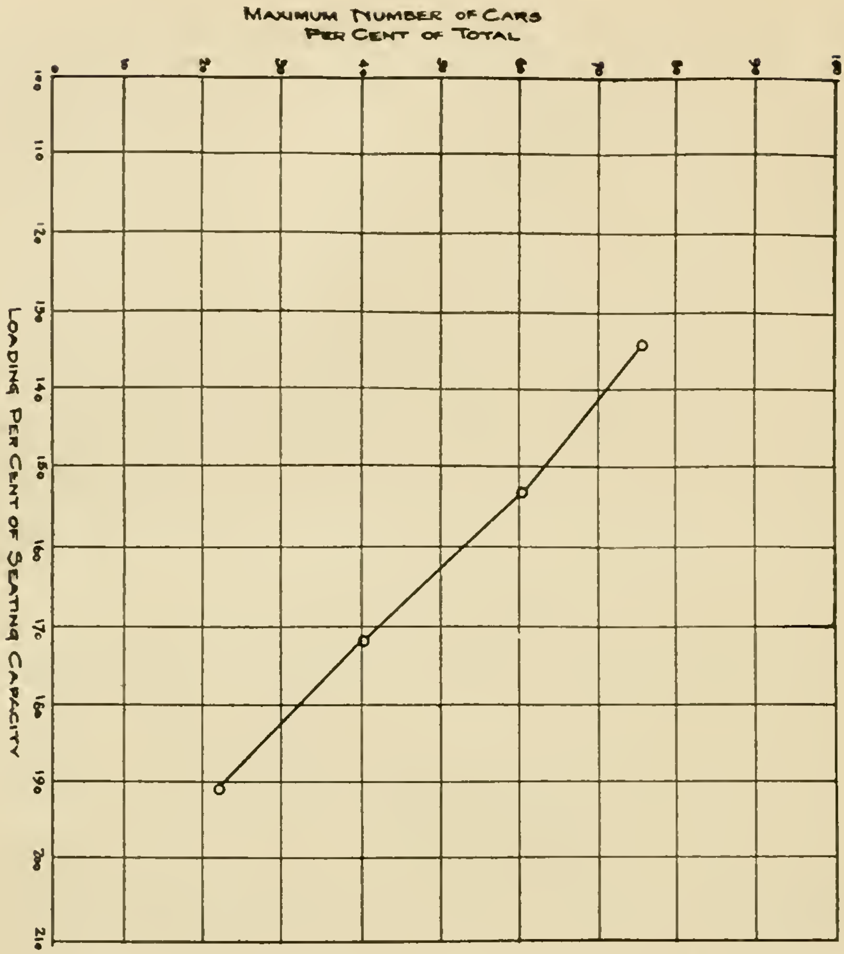

Fig. 6. Curve Showing Proposed Rule for Car Loading.

designated loading shall not be greater than that specified in the following table, to-wit:

Load of cars measured in per cent of seating capacity	Maximum number of cars which are permitted to carry specified loading
191% and over	22%
172% and over	40%
153% and over	60%
134% and over	75%

Human Mortality.

If the data forming the Human Mortality table used by life insurance companies in calculating life insurance premiums be arranged in graphic form, the curve shown in Fig. 7 results.

Normal Probability Curves.

If the normal frequency curve be arranged in cumulative form, curves similar to Figs. 8 and 9 are obtained.

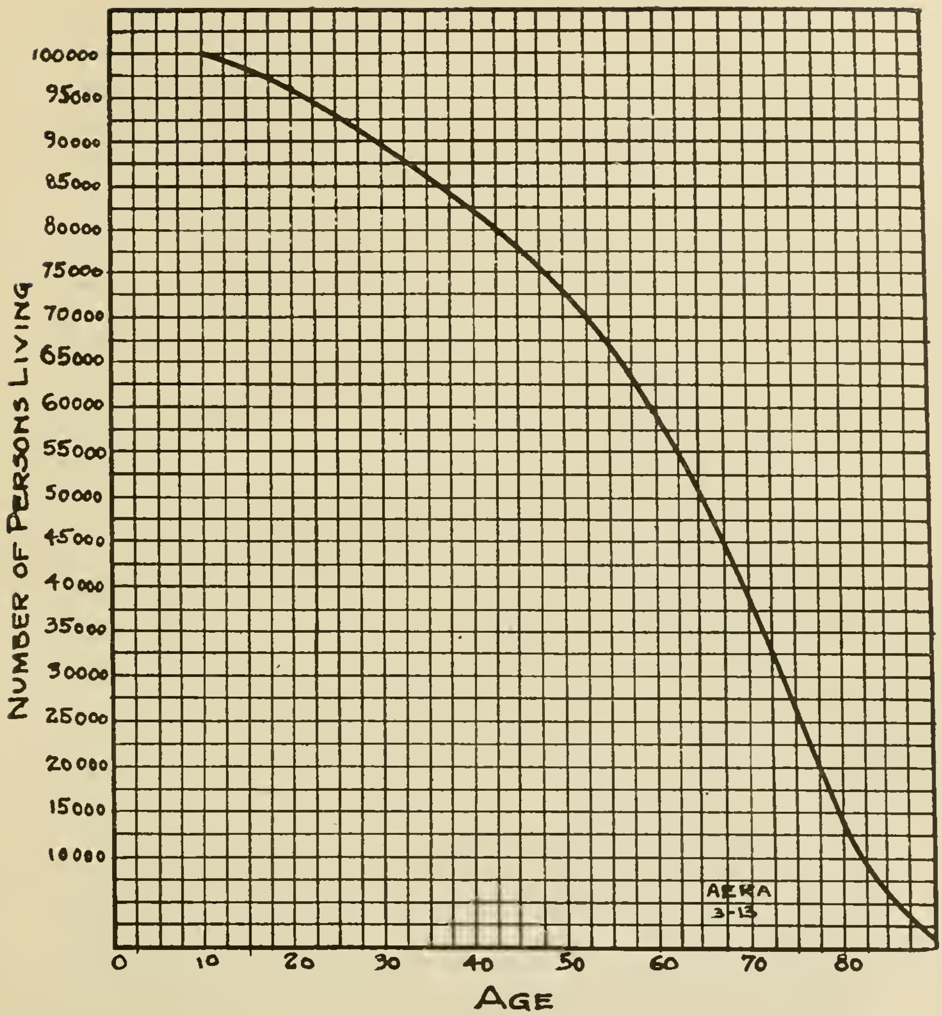

Fig. 7. Human Mortality Curve.

Depreciation of Cast Iron Car Wheels.

Observation on 939 cast iron car wheels showed that their lives in service varied from practically 0 miles to 85,000 miles. When the frequency table is arranged in cumulative graphic form, the curve of Fig. 8 results.

Depreciation Rate of Water Works Pumps.

Of quite similar form to the mortality curves previously shown, is that of water works pumps, derived from data presented by Mr. J. W. Alvard, Am. Soc. C. E., and published in the proceedings of the American Water Works Association. The data expressed in cumulative percentage form are show in Fig. 9.

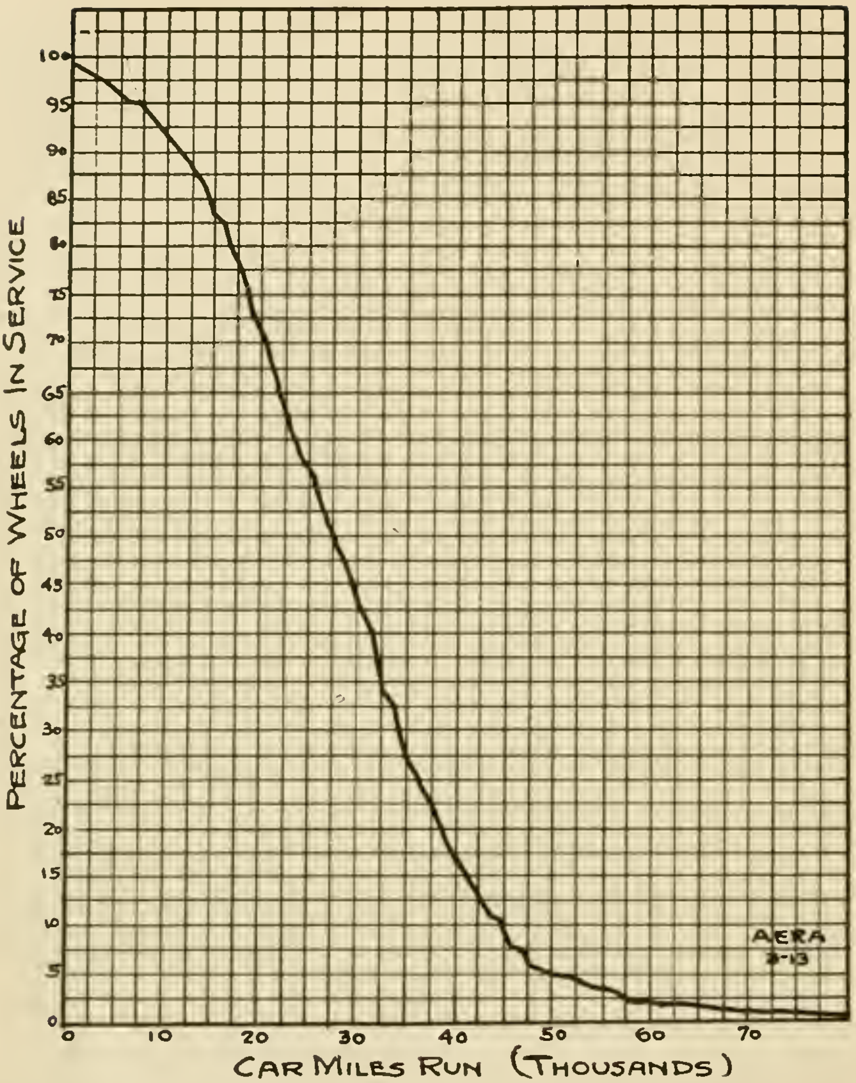

Fig. 8. Depreciation Rate,—Cast Iron Car Wheels.

Mortality of Incandescent Lamps.

Similarly, the lives of incandescent lamps have been graphically represented by the curves published in a bulletin of the National Electric Lamps Association.

Applications to Depreciation Estimates.

It has recently been pointed out that there appears to be a decided similarity between the engineer's problem of estimating the proper annual allowance for financing depreciation and of the actuary's problem of fixing premiums for life insurance. I can best make reference to this branch of the general subject by quoting at length from a paper presented by Mr. Robert Sealy, before the American Electric Railway Accountants' Association, in October, 1914.

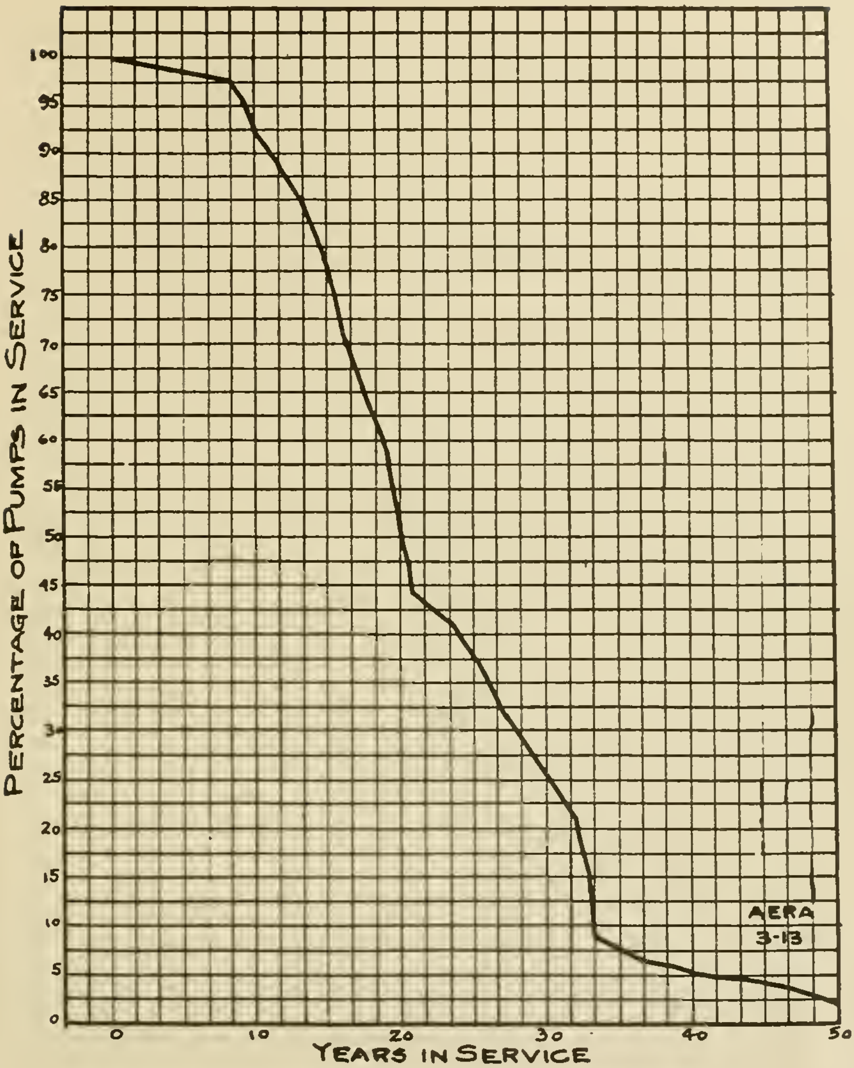

Fig. 9. Depreciation Rate,—Water Works Pumps.

"The conventional methods of estimating the amount to be included in operating expenses as an equitable credit to the replacement reserve are predicated upon the assumption of an average life for the particular class of unit of equipment affected. It is our general experience that the useful lives in service of units of equipment of the same class are not a constant quantity, but vary over a wide range. Abandonment of certain units may be necessary during the first year of service, and other units may have lives running long beyond the assumed average life. Where interest accumulations, as in the sinking fund method, are utilized in creating the reserve, the variations in useful life of units of the same class have a bearing on the amounts accumulated by interest, being less for those units whose lives are less than the

assumed average life, and more for those units whose lives are greater than the assumed average life.

These facts have lead to the suggestion that the principles of insurance be applied to the calculation of the annual premiums or reserve credit, in the expectation that the resulting figures would more nearly represent the actual costs than would the assumptions involved in the application of the ordinary sinking fund or straight line methods.

In order to apply the actuarial method to a given case, it is necessary that some mortality table, showing the varying periods of time during which the units of equipment remain in service be developed. No such mortality tables with respect to any particular class of equipment are in existence but at the present time it is not improbable that mortality tables may be assumed that will be as nearly representative of the facts as the assumed average lives in service of equipment used in the conventional methods of calculation.

An illustration of the method of calculation of such an annual premium may not be inopportune. The following table gives the more or less arbitrarily assumed mortality rate for some unit of equipment. the maximum life of which is twenty years:

If interest on all balances in the reserve be allowed at three per cent, compounded annually computation discloses that the sum of $733.44 would have to be provided at the beginning of the year zero, to provide for the payment of $1.00 for each of the 1000 units abandoned during each of the previous years. This sum of $733.44 is known as the net single premium.

It also appears from the usual actuarial computations that the sum of $9,151.76 would have to be provided at the beginning of year zero, in order to insure the payment of $1.00 for each of the units, during each year of its life. From these two figures it follows that the net annual premium with three per cent interest accumulations on reserve balances which would have been paid during each year of life of each unit, commencing at age zero or when the property units were new, in order to insure replacements, is 8.01 per cent. With a composite life of 10.35 years, the annual charge under the conventional or straight line method of calculating depreciation reserve, is 9.66 per cent, and with a three per cent sinking fund, it is 8.49 per cent. Other mortality or abandonment rates would, of course, give annual reservations different from the foregoing figures. If the provision for replacements be postponed and the pre-

Year	Number of Units in Service at beginning of year	Number of Units abandoned during year
0	1000	7
1	993	21
2	972	27
3	945	50
4	895	56
5	839	60
6	779	65
7	714	73
8	641	73
9	568	68
10	500	67
11	433	65
12	368	61
13	307	50
14	257	44
15	213	44
16	159	43
17	126	42
18	84	42
19	42	42
20	0	
Total		1000
Weighted average life 10.35 years.		

mium be commenced at age five, the annual premium would be increased to 12.78 per cent. In the absence of actual data, an estimate based on any one of the current methods may prove to be as accurate as that based on another."

Other Engineering Applications.

The probability curve has at times been used by engineers for the exterpolation of observational data. Rafter, years ago, applied this method to frequency and magnitude of river floods. Hazen has recently applied it to the extension of run-off data beyond the range of actual experience. In this process he had occasion to develop what he has designated as "Probability Paper," in which one scale has been arranged in accordance with the ordinates of the probability curve. Reference is made to the Proceedings of the Am. Soc. C. E., November, 1913, for Mr. Hazen's paper.

When the principal portion of the frequency curve can be approximated, the limits may be measured by the application of the normal frequency curve. A rough extension to include 99 per cent of all probable cases may be made by calculating the standard deviation and employing the empirical rule of six times the standard deviation previously enunciated.

General.

I have in this discussion only covered the more elementary aspects of this branch of science. It has been my intention to point out the fact that many of the quantities with which engineers deal in every day practice vary over wide ranges, that estimates are, as a rule, subject to large probable errors. In advising a client the engineer should be careful to point out the possibility of differences between actual performances and estimates. The limitations of enigneering calculations should be frankly recognized and the conclusions based thereon be tempered with business judgment.

The subject of statistics when approached by the engineering profession will receive a new impetus and the practical applications thereof will be largely extended, and probably into fields which we can not now predict.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

NEW INTAKE TOWER AND TUNNEL AT THE ST. LOUIS WATER WORKS.

By Edward C. Davis,*
Member of The Engineers' Club of St. Louis.

[Read before the Club, November 18, 1914.]

Since the completion of the Low Service Pumping Station at the Chain of Rocks in 1892, the City of St. Louis has depended for its entire water supply on one intake tower and a tunnel seven feet in diameter connecting this tower with the wet well near the Pumping Station. This tower is located on the western edge of the channel about 1,500 ft. from the west bank of the Mississippi River.

Under normal conditions the capacity of this intake is 125,-000,000 gallons per day. On account of floating ice together with extreme low water which have existed at various periods, the capacity has been reduced to such a degree as to threaten the city on several occasions with a water famine.

In 1900 a report of the water supply was made by a Hydraulic Commission, consisting of Messrs. Geo. Wisner, Benezette Williams and Allen Hazen. In this report it was recommended that a new intake tower and tunnel should be constructed without delay, since, in their opinion it was extremely hazardous for a city the size of St. Louis to be dependent on a single intake for its entire water supply.

Little or no effort was made to improve the intake conditions until Mr. Edward E. Wall was made Water Commissioner, who at once started on the preparation of plans for a new intake and an 8 ft. tunnel, and after thoroughly investigating the natural conditions the plans were completed, and the consent of the United States Government was obtained for the location of the tower and the necessary money appropriated by the Municipal Assembly.

These additional improvements of the intake conditions will increase the intake capacity 150,000,000 gallons per day, making a total capacity of approximately 275,000,000 gallons per day, which means an ample intake supply for many years.

The contract for this work was let in June, 1913, to the Fruin-Colnon Contracting Company, for the sum of $490,355, and at present the work is completed except the superstructures for the

*Engineer, St. Louis Water Department.

screen chamber and intake tower, and barring any unforeseen difficulty these improvements will be in operation the first of the year.

Tunnel.

The new tunnel is approximately 2,767 ft. long, extending from the wet well near the pumping station to the new intake tower located some 700 ft. West and 300 ft. North of the present intake. From the screen chamber the tunnel has a descending grade of 6 per cent for 560 ft. to the shore shaft and beyond this an ascending grade 1 ft. in 1,000 to the down take shaft, thereby affording drainage from both directions to the shore shaft. The tunnel is straight with the exception of a curve with an 80 ft. rail, located at the extreme west end and near the screen chamber. At the shore shaft the bottom of the tunnel is 98 ft. below the surface or 60 ft. below the river bed, while at the downtake shaft it is approximately 35 ft. below the river bed.

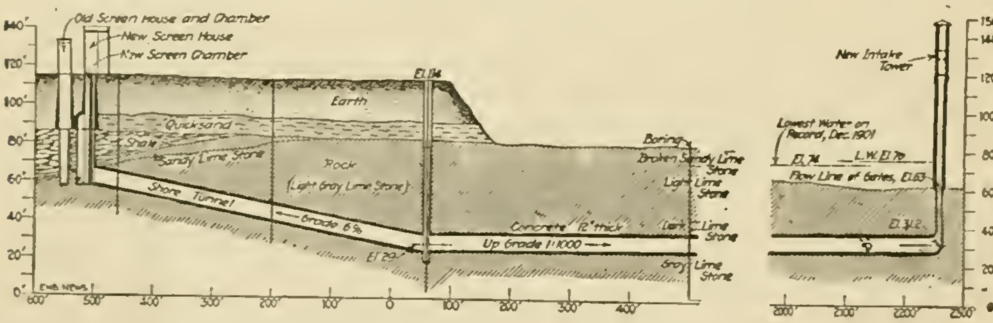

Fig. 1. Profile of Intake Tunnel.

From the shore shaft a connecting tunnel 4 ft. in diameter was driven to the present pump pit shaft through which the main tunnel can be drained in order to make any necessary repairs. The main tunnel, circular in sections, was driven with a diameter of 10 feet.

In the screen-chamber excavation, trouble was anticipated due to caving. To guard against this, steel sheet piling was driven 4 ft. outside the dimension lines. The piling was braced horizontally with sets of 10x12 in. timbers, placed approximately 7 ft. c. to c., and set as the excavation advanced. This excavation was carried 20 ft. in earth and 9 ft. in quicksand without serious difficulty.

The shore shaft, located on the bank of the river, approximately 100 ft. from the water's edge, was used as a working shaft in driving the tunnels. The upper part, in earth and quick-

sand, was excavated with a diameter of 15 ft. 4 in. to a depth of 21 ft. in earth and 12 ft. in quicksand by means of an open concrete crib. This crib was built in place as the excavation advanced. No water appeared in the quicksand and consequently but little trouble was encountered. The time consumed in sinking this crib was eight days. The rock portion of this shaft was excavated with a diameter of 12 ft. and did not vary from the usual methods employed in sinking shafts.

The progress was greatly retarded by running into a number of water seams near the surface of the rock, which gave a flow of approximately 100 gal. per minute. An attempt was made to grout these seams and to a certain extent was successful, although more or less water appeared at different elevations and a 3 in. discharge pump was required to take care of this water. The presence of this pump and time consumed in taking it out and setting it up again at the time of shooting proved to be quite an obstacle in the way of progress, as 34 days were required to sink the shaft 63½ ft., working two 8 hr. shifts a day.

Construction Plant.

The power and compressor plant, located just north of the shore shaft, consisted of three 75-hp. boilers and a two stage air-compressor with a capacity of 950 cu. ft. per min., maintaining a pressure of 100 lbs. in a receiver 3x10 ft. placed outside the compressor house. The air line was 4 in. in diameter from the receiver to the bottom of the shaft, and 3 in. to the face of the heading, reduced at the end by a 2 in. manifold to receive the air hose for the drills.

A rotary pressure blower with a capacity of 4.8 cu. ft. per rev., running at 325 r. p. m., was used for ventilating the tunnel. An 8-in. ventilating pipe was laid from the blower house through the tunnel to within 100 ft. of the face of the heading, and was extended as the work progressed. The average time to clear the tunnel from smoke and gas in order that the shift could get back in the heading was from 12 to 20 minutes.

For transporting muck to the shaft a tract of 24-in. gauge was laid on the south side of the tunnel and wooden side-dumping cars of 24 cu. ft. capacity were used. These were hauled by a 25-hp. storage battery locomotive weighing 3 tons and having a hauling capacity on level track of 10 tons. The muck was hoisted up the shaft by means of two cages, each large enough for a car,

operated by a two-cylinder link-motion reversible hoist, equipped with a drum 48 in. diameter and 48 in. face.

More or less water was anticipated in the east heading, as this end of the tunnel is located under the bed of the river, and facilities for handling 900 gal. per min. were provided. However, the maximum flow of approximately 350 gal. per min. was obtained at the time the tunnel was completed. This water gave little or no trouble, but on account of the slight grade in the east heading a pump of 100 gal. capacity was necessary to keep the water from the face of the heading.

Tunnel Work.

The tunnel force consisted of three shifts working eight hours each, each shift composed essentially of

1 Superintendent.
1 Heading boss.
4 Drill runners.
4 Helpers.
1 Muck foreman.
8 Muckers.
1 Nipper.
1 Signal man.
1 Motorman.
1 Switchman.
2 Cagemen.
1 Electrician.
2 Enginemen.
1 Fireman.
1 Pump man.
3 Laborers.

In addition, on the day shift there was a blacksmith and helper; 1 foreman; four laborers working on track, and one mechanic repairing drills and other machinery.

At the beginning of the work one round was drilled and shot per shift. The drills were then mounted on two columns, one on each side of the heading, with two drills mounted on each column, the 10-ft. cut holes and 8-ft. side holes were drilled, and this round pulled from 4 to 5 ft. per shot. After the organization was more complete, four shots per day were obtained. Columns were still used during this period, and a round of 10-ft. cut holes

and 8 ft. side holes were drilled; this broke an average of 5.16 ft. per shot.

During this latter period the 8 a. m. to 4 p. m. shift found the heading as left just after the last shot on the previous day. They mucked out, set up the drills, drilled the round, and shot it between 2 and 2:30 p. m. The shift went in immediately, mucked out the heading again and had the drills set ready for the 4 to 12 p. m. shift. This latter shift drilled the round and shot it between 7 and 8 p. m.; immediately mucked back, set up the drills and drilled another round. Then the 12 to 8 a. m. shift shot this round between 1 and 2 a. m.; drilled another and shot it between 7 and 8 a. m. The average daily progress in this schedule was 20.5 ft.

The efficiency of the organization was further increased, and during the last two months two rounds were drilled and shot per shift, or six shots in 24 hours. With this schedule, the drills were set on arms mounted on a horizontal bar approximately 6 in. above the center of the tunnel. This was held in position by a jack screw, tightened against the sides and supported in the middle with a jack screw against the bottom. Four drills were thus mounted, two above and two below spring line. The entire round of 16 holes was drilled from this one position of the bar, with cut-holes 6 to 8 ft. and side-round holes 4 to 6 ft. deep, depending upon the time allowed to get the second shot.

Fig. 2 shows the general method of drilling, and each shot resulted in an average advance of 4.27 ft. or 25.6 ft per day. Each man drilled four holes. The cut-holes (1, 2, 3, 4, 5, 6) were shot first; next the side-round holes (7, 8, 9, 10, 14, 15, 16) were shot; then the breakdown holes (11, 12, 13, 17) were shot last. Hole No. 7 was used only when the bottom was high, and this hole was shot with the side round. The holes were started with a diameter of 2½ in. and bottom with a diameter of 1 inch. All shooting was done by means of electric current.

Three strengths of blasting gelatin were used at various times; 40 per cent was found to give too much smoke and gas; 60 per cent was too strong—the explosion was too quick and consequently would break near the surface of the holes and not at the bottom. Finally, 50 per cent was used, and with this the best results were obtained. The charge varied both as to the depth of the hole and the quality of the rock, but on an average one stick (1¼x8 in) per linear foot of hole was used. An aver-

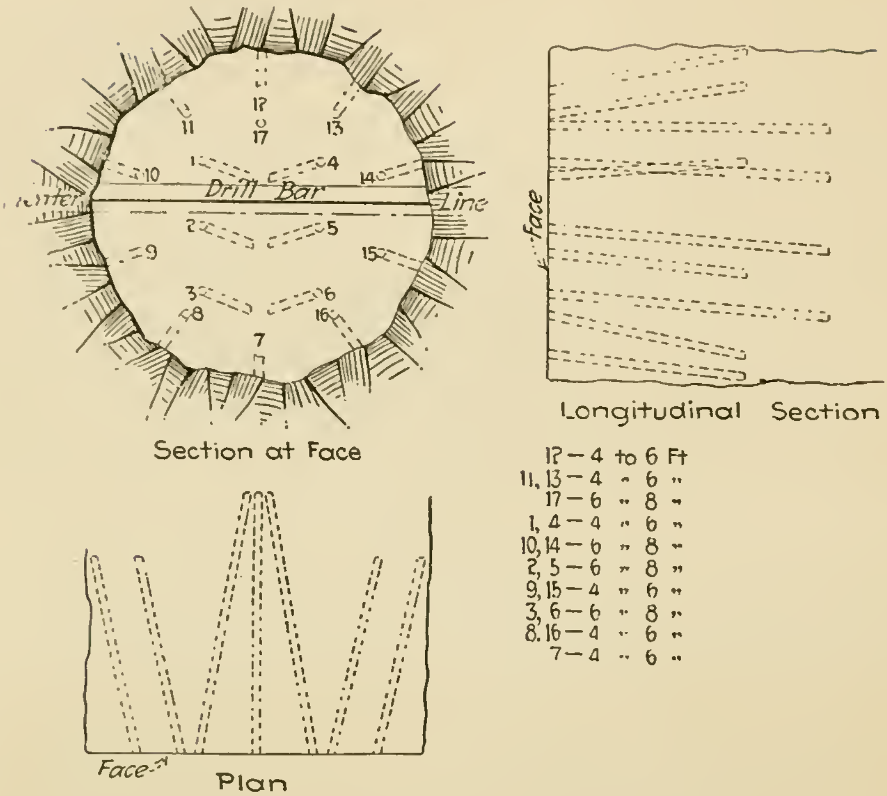

Fig. 2. Arrangement of Drill Holes.

age of 6.7 pounds of powder was used per cubic yard of excavation.

The rock encountered was St. Louis blue and gray limestone, easily drilled and shot. A few horizontal seams and occasionally soft places were run into. These gave but little trouble, and timbering was unnecessary. Both headings were turned September 26, 1913. The west heading was holed December 17, 1913, and the east heading holed March 4, 1914. No effort was made for a record on this work, but for the week ending February 19, 1914, 184 ft. of tunnel was driven, and from January 21 to February 21 inclusive 745 lin. ft. were driven in the east heading. The writer believes that this latter set a new record in the United States for tunnel driving. The heading was driven to a finished line and grade, and the actual excavation ran approximately 10 per cent under that which was paid for under the specifications.

A bonus system of payment was used. A minimum progress of 72 lin. ft. per week was established, and over this the rates were paid per lineal foot of tunnel driven, the payment being divided equally between the three shifts. This amounted to approximately $4.6 per linear foot. No man who had lost over

three shifts during the week was allowed a bonus. About 905 linear ft. of tunnel came under this system and was paid for by this bonus.

Lining.

The tunnel was lined with concrete with a mixture of 1:2:4, no reinforcement required. The concrete was mixed and placed by means of compressed air, the necessary air for this work was furnished by the compressor plant originally provided for excavation of the tunnel plus one 650 cu. ft. compression making a total air capacity of 1,600 cu. ft. per minute.

Air was piped down the shaft through a 4 in. line and reduced to 3 in. at the bottom, the three smaller lines shown entering the mixer are connected to this 3 in. line. The lower pipe is 2 in. in diameter and connects directly into the machine end of the 8 in. discharge pipe by means of which the concrete was conveyed

Fig. 3. Mixer and Conveyor at Bottom of Shaft.

to the forms. The upper pipe line, 1½ in. in diameter, enters the mixer near the top and the relative positions of these two lines prevents the bottom of the machine from becoming clogged and also thoroughly mixes the concrete during transportation. The small air hose shown supplies the air to the small cylinder on the side of the mixer. The function of this cylinder is to close the door at the top of the machine when the batch of concrete material has entered the mixer. This door prevents the escape of air from the mixer top when the transporting air blasts are applied.

Two sets of forms 36 ft. in length were used on this work and were built of structural angles and channels with wooden laggin covered with light sheet metal securely nailed to the laggin. However, this sheet metal was removed at an early stage and a better finish of the concrete was obtained by using plain wooden laggin kept well oiled. The forms were portable and supported on two small trucks running on a 24-in. gauge track placed on the finished invert. The forms were provided with screw jacks built on the trucks for lowering and raising and with turn buckles which were used to pull the wings in laterally to provide the clearance when moving the forms.

For transporting pipe and concrete material, the wooden muck cars and a 25-hp. storage battery locomotive, originally provided during the driving of the tunnel, were used.

Methods.

The land tunnel was lined first. The pneumatic quarter cubic yard mixer and conveyor was set at the bottom of the shaft. The cement, sand and gravel were loaded directly into the mixer from the top of the shaft by building a hopper at the shaft top with a 10 in. pipe leading down and discharging directly into the mixer. This hopper was made with a sliding horizontal door at the bottom so that upon a signal from the man at the mixer this door was opened by means of a lever, allowing the measured batch to drop directly into the machine. The man who operated at this door also let the water in from a barrel at the same time the batch was dropped. This water had a tendency to clog the chute and a 2 in. water pipe was provided and the water entered the machine directly into the mixer hopper at the bottom of the shaft.

One set of forms 36 ft. long was set up approximately 70 ft. from the west end of the shore tunnel, the 8 in. discharge pipe with flange couplings was laid extending through the forms and approximately 70 ft. of intake was laid. After this section of the invert was placed the track was laid at the proper elevation, carefully centered and the forms pushed back over the completed invert and made ready for the concreting at the arch. Heavy bulk-heads were built at both ends of the arch with sand bags,

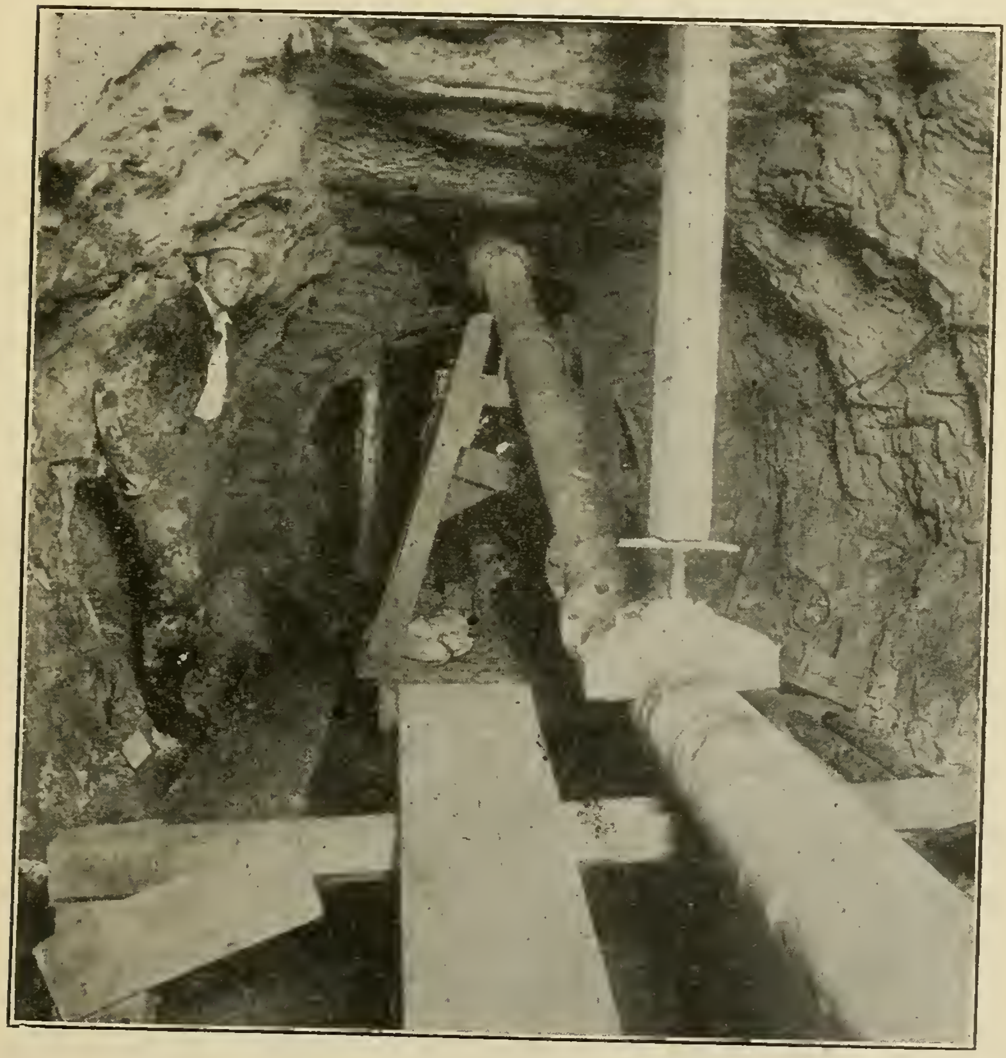

Fig. 4. Showing Bracing of Discharge Pipe and Elbow Connections leading to top of arch, also type of Bulkhead used.

and this type of bulk-head proved to be very effective. The discharge pipe was laid along the tunnel from the mixer to within 20 ft. of the forms and here $22\frac{1}{2}°$ elbow was inserted, then a 20 ft. length of pipe was added which brought the discharge pipe up to the roof of the tunnel and here another $22\frac{1}{2}°$ elbow was placed, then a piece of galvanized pipe about 18 ft. long formerly

used as a blow-pipe in the tunnel was placed which carried the end of the pipe over the forms to about the middle. This galvanized pipe, although easily handled and placed, had to be renewed every third day on account of the wear and tear due to the gravel.

While the shore tunnel was being lined the river tunnel was made ready to receive the lining. A well devised scheme of placing the concrete in the invert by hand throughout the river tunnel was adopted by the contractor, and this proved to be quite a saving in the time as well as expense. No forms were used for this portion of the work, the concrete was mixed at the top of the shaft, loaded into a hopper and dropped down the shaft through a 16x16 in. chute, staggered with one inch bolts placed two feet center to center which bolts also afforded further mixing. Cars 24 cu. ft. capacity were placed directly under the chute ready to receive the concrete and be immediately hauled by the electrical locomotive to the place of depositing. A schedule was arranged by which the concrete would remain in the cars no more than six or eight minutes before being deposited. Two cars were considered a load and round trip was made in ten to twelve minutes.

The work was begun May 4th and completed June 2nd, a total of 25 working days. An average progress of 87 lin. ft. per day of 9 hrs. was made, the concrete running 49 cu. yds. per lin. ft. of invert.

The invert in the river tunnel was finished a few days before the lining of the shore tunnel, which made possible the immediate removal of the mixer and forms to the river tunnel. With the air capacity available, it was decided no effort would be made to shoot the concrete more than 1,100 feet; thus the mixer was moved to a point approximately midway between the shaft and the end of the tunnel, and placed in a hole four feet deep so that the top of the machine came approximately 18 in. below the center of the tunnel where a platform was built. The tracks were elevated so that cars were run up and unloaded directly into the mixer, thus dispensing with more or less labor. The material for the concrete was measured in the hopper originally provided for concreting at the invert, and dumped through the chute into the cars and thence hauled directly over the mixer; the cars were side-dumping and the transferring of the material to the machine was very rapid and but little labor was required. A

one inch water line was run through the tunnel to the mixer and water added directly into the hopper of a machine. Two sets of forms were set up, one at the end of the tunnel, 1,100 ft. from a machine, and the other 500 ft. from a machine; the discharge pipe was elevated 3 ft. above the invert so that it would run through the first set of forms and in no way interfere with the moving.

The first effort to shoot concrete into the forms at the end of the tunnel was more or less a failure and it was decided as a remedy to place two air receivers, 125 to 100 cubic feet capacities, in the tunnel at the mixer, which relieved the situation. Little or no trouble was thus experienced in shooting the concrete the required distance. The forms were poured alternately requiring from two to four hours, depending upon the distance between the mixer and the forms.

While this portion of the tunnel was being lined a perceptible difference in the quality of the concrete between the rear and the front of a form was noticed. Upon investigation it was noted that the gravel in the concrete would discharge at a rapid velocity and deposit itself in the rear part of the forms and the mortar would drop almost directly from the end of the pipes—about midway of the forms. A scheme to overcome this condition was devised by which a 10 in. galvanized pipe 12 ft. long was slipped over the 8 in. discharge pipe leading from the end of the arch to the center and this pipe was made loose so as the forms were filled the pipe could be slipped back, thus keeping the end of the discharge pipe no more than 4 ft. from the place where the concrete was being deposited. This proved quite effective, and the quality of the concrete was more uniform throughout the form and much more satisfactory results were obtained.

After the part of the river tunnel between the mixer and the end was completed the mixer was again moved to the bottom of the shaft and one set of forms pulled ahead on the track to a point 500 ft. from the machine and the concreting handled in the same manner as was employed in the shore lining.

Progress.

The work of lining the shore tunnel was begun April 28th and completed May 22nd, a total of 20 working days. During this time 446 lin. ft. of tunnel lining, including both invert and arch, was poured, an average of 22.3 ft. per day. The progress

was rather slow, due to the fact that only one set of forms could be used, the tunnel being short, together with any faulty details in design, which had to be overcome and new methods adopted after a series of experiments.

The work of lining the river tunnel was begun June 5th and completed August 3rd, a total of 69 days. Of these 10 days were Sundays on which no work was performed; 6 days were lost on account of fire which destroyed the compressor house, and three days were consumed in moving the machine, thus leaving a total number of 50 working days, during which 2,167 lin. ft. of arch was completed, an average of 43.4 lin. ft. per day. Two sets of forms were used and poured alternately. The forms were pulled from 12 to 16 hours after pouring and in a great many cases two arches were poured in 24 hours. Each form held from 100 to 125 batches, each batch consisting of 1½ sacks of cement, 3 cu. ft. of sand and 6 cu. ft. of gravel, making approximately 40 cubic yards.

Forces.

The concreting force employed during this work varied depending upon the number of arches poured per day. The average force per day consisted of one superintendent, one compressor engineer, one fireman, two men on loading materials from the cars to the storage yards, four to five men wheeling material from the storage yard to the hopper at the top of the shaft, one motorman, who also took care of the bull gang of two to three men doing odd jobs and maintaining the track, one foreman and six laborers moving forms and adjusting the discharge pipe preparatory to concreting, one man on the forms while the concrete was being poured and one concrete finisher.

General.

After the lining was completed, quite a number of hollow places were found between the top of the concrete and the roof of the tunnel. These hollows were caused by small rock projections from the roof, the concrete while traveling at a rapid velocity would hit these projections and deflect to either side. The space in these hollows varied from 3 to 8 inches in thickness. The concrete was carefully sounded throughout the tunnel and where hollows were discovered a two inch hole was drilled with an Ingersol Rand jack hammer drill, grout pipes inserted and the hole

filled with grout; one part cement and two parts sand. A Ransome Cannif grout machine was provided and a pressure of 90 pounds was maintained. Where honeycomb places existed in the concrete this grout was forced into the voids and thereby strengthened any weak spots.

Delays were quite frequent, due to the insufficient air capacity, while the concrete was being shot a distance of 500 to 1,100 feet. In the writer's opinion this was due to too large discharge pipes in connection with the one-quarter yard mixer used. The amount of air consumed varied from 1-2 to 1-7 cubic foot of free air per lineal foot of discharge pipe. A pressure of 110 lbs was maintained at the receiver and by the time the batch had been discharged the pressure was reduced from 110 lbs to 25 to 40 lbs, depending upon the length of the discharge pipe. There is no doubt if a 6 in. discharge pipe had been used instead of an 8 in. the consumption of air would have been materially reduced, thus effecting a better progress and at the same time saving expense.

Intake Tower.

The tower covering the downtake shaft is located on bed rock at elevation 60 or approximately 12 ft. below extreme low water. Below elevation 80 the tower is 70 ft. long and 26. ft. 8 in. wide with vertical sides, triangular nose and semi-octagonal back; between elevations 80 and 106 the back is semi-circular, the sides. battering ½ in. per ft., and the nosing slopes back to form an ice breaker with its elevation at 73.2. Above this point the front of the tower is semi-circular and sides are vertical; above the 106 both ends are semi-circular and the sides are vertical. A stone balcony at elevation 117 overhangs the substructure. Above this point is the superstructure containing the operating chambers, the balconies with sleeping quarters for the operating force and a room above for the tower keeper. The substructure is of concrete faced with granite on the nosing and below elevation 80 and a facing of sawed Bedford limestone, elsewhere. The superstructure and balcony is of Bedford limestone with interiors of white enameled brick and roof of green slate.

The tower was designed in the same manner as a bridge pier to resist wind, ice and current. In the interior below the operating floor are two wells one of these 10 ft. x 11 ft. with semicircular end forms an upward extension of the downtake shaft;

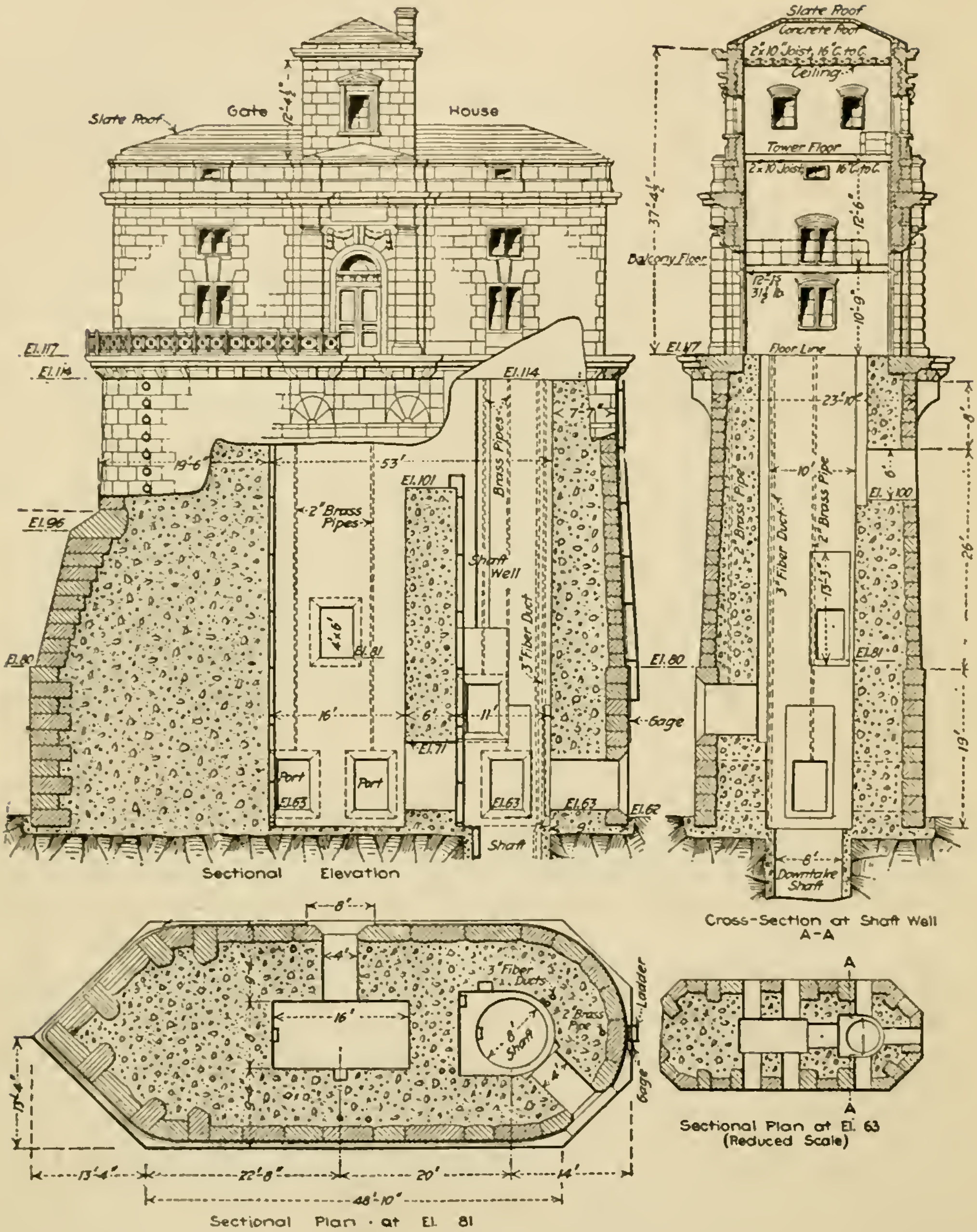

Fig. 5. Intake Tower and Gate House.

the other is a rectangular chamber 8x16 ft., the two being connected by a 6x8 part in a partition wall and filled with rectangular shore gate.

All ports open into one of these wells and are closed by 4x6 shore gates located in the walls and operated by hydraulic lifts, all ports opening into the river, except the upper one. These ports are fitted with cast iron gratings which prevent the entrance of large blocks of ice, logs or drift of any kind. As the lowest stage of the river recorded at the Chain of Rocks is 72.8

the seven lower gates at elevation 63 should at all times insure against any water shortage.

The difficulties of unwatering the site for the intake tower proved to be quite a problem as it is located on bed rock in about 18 to 22 ft. of water with a current of 3 to 4 miles. The method of constructing an angular caisson was adopted. The caisson was built of yellow pine containing approximately 200,000 feet. It is 94 ft. long and 52 ft. wide, which allows 4 ft. all around for working space. The inner and outer walls of this caisson are about 8 ft. apart and the working chamber is 7 ft. high. It has two man locks and supply shafts for four material locks through the deck. The walls of the work chamber are of 8 in. timber and they are continued at this thickness to a point about 9 ft. above the deck. From there to the top, which is 26 ft. above the cutting edge the walls are of 6 in. timber. The outside of the entire caisson is sheathed with 2 in. planking and caulked. The deck and sides of the working chamber are also caulked, but not sheathed inside. The entire inside wall of the caisson is sheathed but not caulked. The caisson is braced across from one side to the other with 12x12 in. timbers laced together with 3x12 in. planks and the walls were also braced apart with 6x12 in. timbers and 3x12 planks. It was partly built in the city at a point about 8 miles down stream from the site of the tower. To float it four barges 20x48 ft. and 5 ft. 2 in. deep were first constructed on the shore and launched. These were tied solidly together with timbers and bracing and the caisson built on them until it had reached a point about 10 ft. above the cutting edge, when the whole structure was pushed up the river by a steamboat.

The new intake tower is located in 20 to 22 ft. of water during normal water stages, on a very uneven rock bottom and in a current of 3½ to 4 miles per hour. It was therefore quite a proposition to anchor the caisson. For the up stream anchors four 3¼-inch holes, 4 ft. deep, were drilled in the rock bottom of the river and four 3-in. eye bolts, 4 ft. long with a 10x12-in. ring in each, were driven down into the holes. To these, four 1-in. steel cables were shackled. For the west side, two 2-in. eye bolts were used, one for the up stream and one for the down stream ends of the caisson. To each of these, two lines of ⅝-in. steel cable were attached. As all of the rock bottom east of the

tower location was covered with sand from 2 to 6 ft. deep, holes could not be drilled for the east side anchors, so three 6x6-ft. concrete blocks were used for each anchor. For drilling the holes a platform was built upon a 22-ft. section of 12-in. pipe, imbedded in a 6x6x3 ft. concrete block, and with a 6x6 ft. plank platform on the top of the pipe. This was set on the bottom of the river with a derrick boat and a steam drill mounted on a

Fig. 6. Drilling Holes in River Bottom.

tripod was placed on the plank platform. The drill was operated by steam obtained through a steam hose from the boiler on the derrick boat. The drill which was 24 ft. long was let down through the pipe, the hole drilled and the drill moved away. After that the eye bolt with a small cable attached was let down through the pipe and driven firmly into the hole with a heavy ram which was small enough in diameter to be lowered through

the pipe. The drill platform was then moved and a diver shackled the anchor cables to the rings.

When the caisson had been built 16 ft. above the cutting edge and caulked it was launched. It had been built on greased ways laid on the decks of the barges and before launching all bracing between the barges was removed. A derrick boat was anchored on each side of the caisson and about 75 ft. distant from it. These barges were anchored up stream to the upper caisson anchors and were also made fast to the side anchors on their respective sides. To haul the two barges out from under the caisson on each side, a set of double blocks rove with 1½ in. manilla line was used for each barge, with the hauling parts of the lines run to the winch heads of the hoisting engines on the derrick boats. One block was hooked into a steel cable sling which passed around the barge under the caisson and the other block was made fast to the timber head on the derrick boat. These lines were hauled taut and the barges under the caisson were then scuttled. A steady strain was kept on the hauling lines and when the buoyancy of the caisson began to relieve the load on the barges the latter slid out nicely with the exception of one which was jammed between the cutting edge of the caisson and a high point on the rock bottom. Even that one gave very little trouble, however, as after the slack had all been pulled out of the anchor cable opposite to it, the barge came out with no more damage to it than a few splinters knocked off.

The caisson was then built up to its full height and ballasted

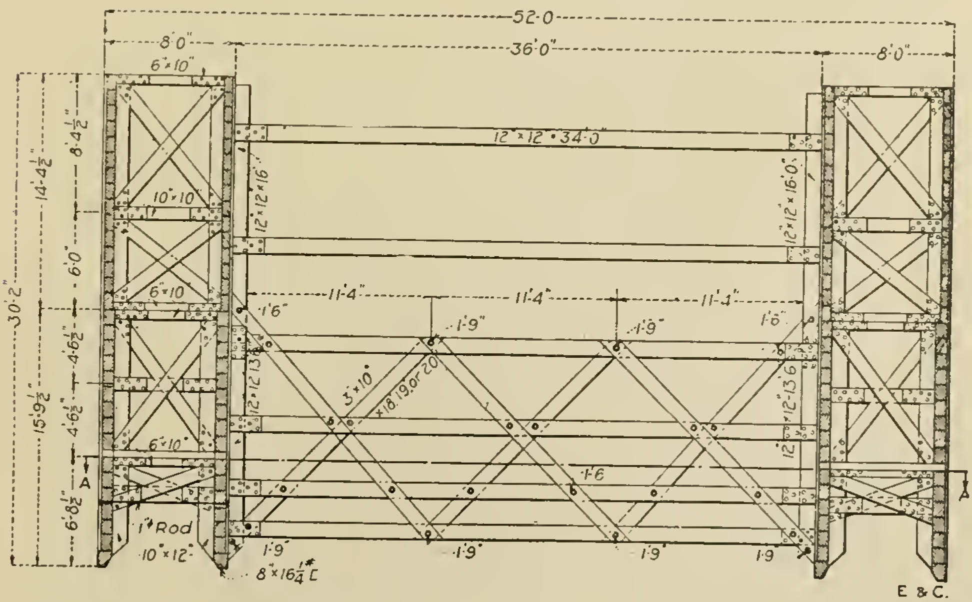

Fig. 7. Vertical Section of Caisson.

with several feet of clay placed on the deck. An endeavor was then made to put air on it but the severe racking it had received from the launching and from its resting on the uneven bottom had opened the seams and with the compressor on hand (675 cu. ft. per min. capacity), it was impossible to raise the pressure enough to get inside the working chamber. To tighten it up 2 in. pipes were driven down to the deck through the clay and alongside the vertical timbers where the most leakage seemed to be. These pipes were cleaned out with an air jet and grouted under 40 to 60 lbs. pressure. After the grout had set it was possible to get air enough in the working chamber to force the water about 2 ft. below the deck, after which men could get inside and stop the leaks. This allowed the air to be raised until the cutting edge was exposed. The greatest pressure carried at any time was 8 to 9 lbs. The rock inside the working chamber was then cleaned off and the edge sealed down to the rock with concrete. This concrete was brought up about 2 ft. above the cutting edge and allowed to set, after which an effort was made to pump out inside the coffer dam. An examination by a diver showed that there were several large leaks under the edge of the caisson. Men were then set inside the working chamber and wherever a leak had been located a part of the concrete was cut out and this usually disclosed a gravel pocket under the concrete. These pockets were cleaned out and refilled with rich concrete, and after that had set the coffer-dam was readily pumped out and the air finally taken off the working chamber.

When the loose mud and sand inside the coffer dam had been removed and the surface of the limestone rock cleaned up, a rather startling condition of affairs was disclosed. The rock was criss-crossed with seams and honeycombed with cavities up to 3 ft. in diameter and 2 to 4 ft. deep and as the rock was excavated it was found that between the different strata there were numerous channels of all sizes resembling in appearance worm holes. Two of the seams were especially bad and the leakage from them amounted to about 3,000 gallons per minute. A fairly satisfactory rock was found about 4 ft. below the surface and after the rock had been excavated to that level the work was shut down on December 28th for the remainder of the winter before starting to place masonry for the tower itself. This was done as the high water and ice were due at any time. All floating equipment was laid up for the winter and the machinery was taken ashore.

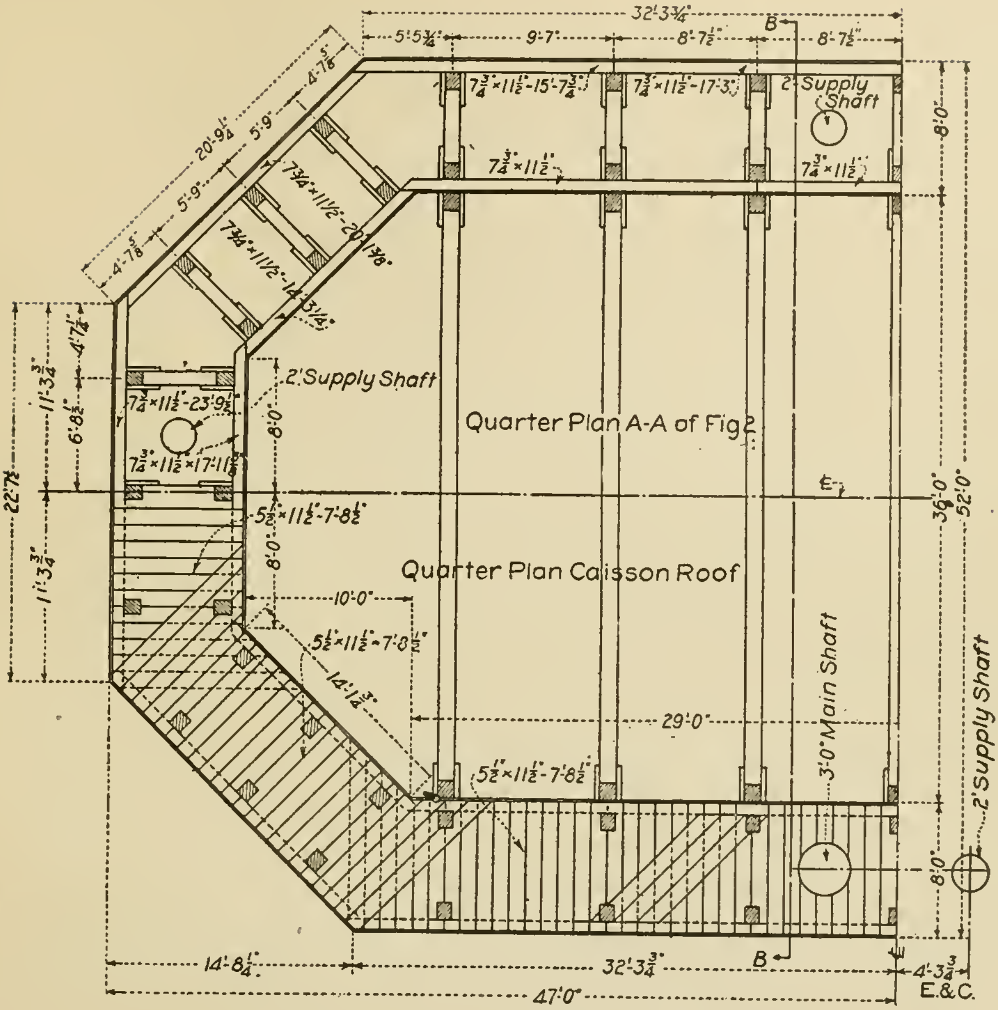

Fig. 8. Quarter Plans of Caisson.

Work was resumed in July, 1914. The caisson had stood the wear and tear of the drift and floating ice, also a collision which sunk the excursion steamer *Majestic*. Practically the same pumping capacity was required to unwater the caisson and within two weeks from the time of beginning, the foundation was made ready for masonry.

After the masonry had been laid above high water, the river shaft was sunk and the connection with the tunnel made, also the coffer-dam removed.

After the caisson had been set on bottom a power barge 30x120 ft. was moored to the down stream end of it and remained there until the work was shut down. On this were three 60 hp. locomotive type boilers, one single stage 675 cu. ft. per min. Ingersoll Air Compressor, one 7½ KW. 110 volt direct connected lighting set, pumps for water jet, cooling water, etc., and a dry house for the men. The boilers supplied steam for running the

compressor, lighting plant and for the pumps which were used for keeping the water out of the coffer-dam. These latter included a 12 in. and a 6 in. direct connected centrifugal pump, a 5 in. belted centrifugal pump and a 5 in. and an 8 in. Emerson pump.

Two derrick barges were also used and on one was a 150 cu. ft. capacity Westinghouse compound air compressor which was used for grouting and to supply air for the hammer drills with which all drilling inside the coffer dam was done. A steamboat was on the work at all times and two gasoline launches were also used to transfer men and material between the caisson and the loading dock. This dock was located about ¾ of a mile down stream from the tower on the west bank. On the level ground near the top of the river bank a spur from the City Water Works Railway was run in. At the top of the bank was a guy derrick with a 75 ft. boom and an 80 ft. mast. From a point about half way down the bank a pile dock ran out into deep water carrying a standard gauge railway track. The derrick transferred material from the railroad cars to flat cars on the dock, from which it was picked up and loaded on barges by a derrick barge. Further along the siding was another guy derrick with a 50 ft. boom and these two derricks handled all stone, steel, gates, etc., for the intake tower and piled it ready for loading on the barges when needed.

[Note—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the Journal.]

THE LOCAL ENGINEERING SOCEITY.

Discussion by J. F. Druar,*
Member of the Civil Engineers' Society of St. Paul.

[Volume 53, page 64, August, 1914.]

I have read with pleasure the paper by Orrin E. Stanley, on the Local Engineering Society, and the editorial comment, and am moved to express some ideas that have been accumulating for years in the back of my brain.

The trouble with most of the profession is that these ideas remain at the back of the brain and are never expressed, and that the floor is not used for such expression. I suggest that more use be made of the floor for speaking, suggestions and debate than for expectoration and cigar stubs. However, a good healthy smoker is beneficial and the smoke has a tendency to kill disease germs and, at the same time, stimulate debate and discussion, i. e., if cabbage and cigarettes are barred.

I believe as the minister who was training his Sunday-school children to sing. In the course of the lesson, he had them start, "Little Drops of Water." The start was very ragged and he pounded the lecturn with his baton and said, "Children! Children! do put a little spirit in it." Spirit is what we need and this can be obtained by the co-operation of the members and of the public.

Take the public into your confidence and start something and fight it through. In other words, most engineers lack in aggressive qualities and should cultivate them. To make a success, it is necessary to be original and to be ready and willing to adopt new ideas and methods when there is an advantage in so doing.

I have on my dresser a motto which reads as follows: "Read, think, act, young man; if successful, do not get a swelled head, but praise Him from whom all blessings flow." While that has been before my eyes for perhaps five years, I have not fully followed the advice contained therein, but I can heartily recommend the thoughts to all engineers.

What do you do if you are appointed on a committee to look up some public affair, or to prepare a paper on some sub-

*Consulting Engineer, St. Paul, Minn.

ject? Do you get at it at once or do you put it off as being too busy? Do you investigate every possible angle of the work and study it from its source, or do you put it aside and, after several temporary extensions of time, find that your last possible excuse has gone, and that you are up against the necessity of producing the paper or accepting the results, and you frantically produce authorities and extracts and burn midnight oil or juice to prepare a paper which you have to deliver the following day?

Probably you do the latter, as do the majority. Then, when you arise before your audience you hesitate, you halt, you flounder, you sweat, you pick at the seams of your pants, you stand on one foot, now on the other, you tremble, you wonder how it is going, you forget, you stammer, you have your audience, not. Then, after finishing, some intelligent soul puts a question to you which amounts to: What have you been talking about? Another puts you to shame by asking an elementary question you do not have an answer for. Why? Because you were not prepared in the right way. Don't one of you readers say this is not so! I have been through it several times. I have seen some of the audience, which was sparse at first, start to leave or talk among themselves. You have had the same experience. Why? Go back to my read, think, act. Thanks to that, when I prepare a subject now, I know it from A to Z, and I will not talk unless I do. I can now take the floor with more confidence, and when I get over the first two minutes of stage-fright I get into my subject so completely that I forget myself. I still have a dreadful, clammy, unreal feeling when I know I may be called upon next and I do not enjoy the interval.

All this to say what I could have said in a few words, and that is, we are not prepared individually nor as a body to make any headway in presenting engineering facts or data, or in forcing the recognition our profession deserves.

Therefore, let us get together, become influential, gather together for business, force issues, create sentiment, build influence as we build our structures. Look about you, in your own home town. Surely there is some enterprise that you and your co-workers can plan, organize and push to completion through the agency of the Society and its friends. And right here let me say, create and make friends for yourself

and the Society by open meetings. Give the meetings publicity, obtain prominent speakers, if possible; get crisp meetings. Do not wrangle over business meetings, get them over; business such as you have to transact at meetings, if properly handled should take about ten minutes; we wrangled at one meeting for a whole evening over a wet or dry banquet. It was nonsense. One engineer tells me he does not go to the meetings because he learns nothing. Incidentally, I might say, I have never seen that man take the floor.

I have to say one thing, and that is, the local Society can be, and should be, a success in a business, scientific, social, and common-sense way. Look about you and see how many engineering friends come to your house. You will find that doctors, lawyers, traveling men, musicians and others predominate and, incidentally, carry your views away with them, if you have any. Meet your fellow engineer and rub elbows with him. He is not laying to put something over on you if you open your mouth and express yourself on a subject. Encourage social intercourse, intermarry and grow a race of engineers. Meet socially with the wives, daughters and sweethearts of the members of the society. Plan excursions, semi-technical in nature, plan discussion and debate, obtain publicity, get on your feet and fight all the time for recognition of the profession. Express yourself freely; we cannot all dig canals, tunnel rivers, or build ships, but we can hit the high grade under high pressure in our own chosen line and obtain the recognition and prominence our efforts deserve. Learn to express yourselves on the floor in debate and in conversation. Be convincing, prove your points in nontechnical language. Go into your profession and bend your efforts to make your profession bigger, better and broader. The late Robert Thurston, M. M. E., Dean of Sibley College, Cornell University ("Dear Old Bobby," as his students called him behind his back), gave a good thought to all young engineers in the making, and this was, "Engineers through their own belated efforts have not obtained the recognization their profession merits and that sometime they will come into their own, and that proper credit will be given them."

It seems as if this were the writing on the wall, for at present, it appears that we are to have an engineer as Presi-

dent of the good old U. S. A., the first, I believe, since George Washington's time. I refer here to the builder of the Panama Canal, Col. George W. Goethals. Let us hope that such will be the case and that the engineering profession shall have a say in the enormous developments to come.

[NOTE—Further discussion of this paper is invited, to be received by Joseph W. Peters, 3817 Olive Street, St. Louis, for publication in a subsequent number of the JOURNAL.]

ASSOCIATION
OF
ENGINEERING SOCIETIES

Vol. 53. DECEMBER, 1914. No. 6

PROCEEDINGS.

The Engineer's Club of St. Louis

The 787th meeting of the Club was held in the Club Rooms, Wednesday, November 11, 1914, at 8:15 p. m., as a Joint Meeting with the Associated Engineering Societies of St. Louis, under the auspices of the St. Louis Section of the American Institute of Electrical Engineers. There were present 51 members and 8 guests.

President A. P. Greensfelder called the meeting to order.

The minutes of the third Joint Meeting under the Joint Regulations were read and approved.

President Greensfelder called upon Mr. S. N. Clarkson, of the A. I. E. E., to preside. Chairman Clarkson then presented Mr. Charles S. Ruffner, General Manager of the Mississippi River Power Distributing Co. and the Electric Co., of Missouri, who read an illustrated paper on "Some Practical Applications of the Principles of Statistics."

Discussion followed.

Adjourned 10:15 p. m. JOSEPH W. PETERS,
Assistant Secretary.

The 788th meeting of the Club was held in the Club Rooms, Wednesday, November 18, 1914, at 8:15 p. m., as Ladies' Night, light refreshments being served. There were present 160 members and guests. President A. P. Greensfelder presided.

The presiding officer called for the reading of the proposed Rules Governing the Building Fund of the Engineers' Club of St. Louis as follows:

> 1. In order to inaugurate and encourage a movement looking ultimately to the ownership of suitable land and buildings for the use of the Engineers' Club of St. Louis, a fund is hereby created to be known as THE BUILDING FUND OF THE ENGINEERS' CLUB OF ST. LOUIS, and the sum of one thousand dollars ($1,000.00) is duly appropriated and set aside therefor by vote of the members of said Club.

2. The Building Fund may be increased by subscriptions, gifts, endowments or bequests of individuals or organizations, by appropriations or assessments from the Engineers' Club of St. Louis, and by investments. Those who donate less than $100.00 shall be known as *subscribers*. Those who donate $100.00 or less than $1,000.00 shall be known as *contributors*. Those who donate $1,000.00 or more shall be known as *Patrons*. The names of all donors shall be published annually.

3. The establishment of this fund affords an opportunity for engineers and others to offer substantial recognition of the dignity and importance of the engineering profession as a leading factor in the welfare and development of the community.

4. The Fund shall be administered by a Board of Trustees who shall receive, maintain, invest and disburse the same, and report annually thereon to the Club. Said Board shall be composed of the President of the Engineers' Club and six senior past-presidents who are resident members of the Club and willing to serve.

5. The President of the Club shall serve as presiding officer of the Board. The Secretary and Treasurer of the Club shall act in their similar capacities for the Board. The Treasurer shall be under bond paid out of the Fund. The Board shall meet semi-annually or upon call of any three members thereof. The minutes of all Board meetings shall be read to the Club at its following meeting. Five Trustees shall constitute a quorum. Four affirmative votes of the Board shall be necessary to pass any measure. The Fund shall be administered in its full name. The Board shall enact all other measures necessary for its action.

6. The Board may appoint an Advisory Council not exceeding ten in number, to serve for life until voluntary retirement, which Council shall assist the Board in its duties.

7. These Rules of Government may be amended or suspended, or any portion of this fund be diverted, for building fixtures or library, only on recommendation of five Trustees and acceptance thereof by a majority of the members of the Club at a meeting called for that purpose and affirmation of three-fifths of the Club members voting by letter ballot returnable ten days after issuance.

Motion made, seconded and unanimously carried that the Rules governing the Building Fund of the Engineers' Club of St. Louis, as published in the October Bulletin and read before this meeting be adopted.

The presiding officer called for the reading of the proposed amendment of Section 12 of the By-Laws as follows:

Sec. 12. Nomination of Officers.—The members present at the first meeting in November of each year shall elect, by ballot, a Nominating Committee of five members. No member shall serve upon the Nominating Committee two consecutive years. The Nominating Committee shall select two or more Candidates for each office for the ensuing year and report to the Club at the second

meeting in November. A copy of the report of the Nominating Committee shall be mailed to each member not less than two days prior to the Annual Meeting. At the Annual Meeting, the names proposed by the Nominating Committee shall be placed in nomination. Additional nominations for any office may be made at the Annual Meeting, by written request, signed by five members. In the list of candidates for each office upon the ballots the names shall be arranged alphabetically.

Motion made, seconded and unanimously carried that the proposed amendment to Section 12 of the By-Laws, as published in the October Bulletin and read before this meeting be adopted.

In accordance with the By-Laws the following Nominating Committee was elected: F. E. Bausch, Chairman; John Hunter, F. G. Jonah, W. W. Horner and Montgomery Schuyler.

The Presiding Officer then called up on Mr. F. E. Bausch, who introduced Lieutenant L. P. Warren, U. S. N., who read an illustrated paper, entitled, "The Submarine." The paper dealt with the construction and operation of this class of war vessel. A short discussion followed.

Adjourned 11:00 p. m.

JOSEPH W. PETERS,
Assistant Secretary.

The 789th meeting of the Club was held in the Club Rooms, Wednesday, November 25, 1914, at 8:15 p. m. First Vice-President, John W. Woermann, presided. There were present 28 members and 5 guests.

The minutes of the 783rd, 784th, 785th, 786th, 787th and 788th meetings of the Club were read and approved. The minutes of the 557th and 558th meetings of the Executive Committee were read.

The Assistant Secretary read a letter from Edward E. Wall, presenting to the Club bound copies of Specifications and Drawing for the Intake Tower and Tunnel and for the Filter now under construction at the Chain of Rocks. Motion made, seconded and carried that these books be received, placed in the Library and a letter of thanks be sent to Mr. Wall.

Motion made, seconded and unanimously carried that the Assistant Secretary write a letter of thanks to Mr. C. T. Moorshead of the Illinois Glass Company expressing appreciation of the courtesy extended to the Club upon the occasion of the trip of inspection through the plant of the Illinois Glass Company on October 31, 1914.

Mr. F. E. Bausch, Chairman of the Nominating Committee, announced the following candidates for nomination to the various offices in the Club for the ensuing year:

For President—E. L. Ohle, H. J. Pfeifer, J. W. Woermann.

For First Vice-President—W. E. Rolfe, E. D. Smith, H. Spoehrer.

For Second Vice-President—H. I. Finch, W. O. Pennell, H. C. Toensfeldt.

For Treasurer—J. H. Boughton, F. T. Cutts, C. W. Martin.

For Secretary—S. W. Bowen, J. McD. Johns, R. Toensfeldt.

For Librarian—L. Chivvis, H. R. Setz, E. H. Tenney.

For Directors—F. J. Bullivant, H. J. Elson, O. H. Harting, G. M. Peek, G. R. Wadleigh, J. A. Whitlow.

For Members of the Board of Managers of the Association of Engineering Societies—E. H. Abadie, F. A. Berger, L. R. Bowen, E. L. Brown, S. N. Clarkson, Nelson Cunliff, L. A. Day, J. B. Emerson, J. T. Dodds, C. L. Hawkins, S. B. Russell, C. A. Waldo.

The report is signed by F. E. Bausch, John Hunter, W. W. Horner and F. G Jonah.

The presiding officer then presented Mr. Edward C. Davis, Engineer, St. Louis Water Department, who read an illustrated paper on "The Chain of Rocks New Intake Tower and Tunnel."

Discussion followed.

Adjourned 10:30 p. m.

JOSEPH W. PETERS.
Assistant Secretary.